SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, JANUARY 12, 1906.

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE NEW ORLEANS MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

REPORT OF THE GENERAL SECRETARY.

THE third meeting of the association was held in Charleston, S. C., in 1850. At that time there were 622 members. The number at the meeting is not given. It was probably a negligible quantity, for until 1905 the experiment of a meeting in the south was not again tried; though, of course, the failure to meet again in that section was largely due to the fact that until recently the only time available for an annual meeting has been the hot summer months. The registration at New Orleans was 233. The attendance of unregistered members of affiliated societies would raise this number to a probable total of 300.

It will be noticed that a comparatively small number of affiliated societies thought it wise to follow the association on so long an excursion from the usual places of meeting. Assurances have been abundantly given that in the New York meeting most of the societies usually affiliating will resume that relation to the association.

The meeting of 1904 reported 4,175 members. That of 1905 about 4,500. The increase has been larger than usual and important. As soon as the association can count on 5,000 active members most of its financial problems will be solved. It is a question whether as a means to this end some special arrangement should not be made with the members of affiliated societies who are not yet members of the association. Certain it is that the experience of America, as well as of France and Great Britain, shows that the American Association fills a place peculiarly its own. The loss of its unifying influence and its aggressive propaganda of science would leave a void which nothing else could fill. There should be no difficulty in reaching harmonious relations satisfactory to all interests.

The experience at New Orleans makes it doubtful whether the experiment of scattering the vice-presidential addresses through the week is a wise departure. The meeting loses the initial momentum of a more compact arrangement.

The suggestion was made at this meeting that a distinctive badge for life members of the association should be designed and sanctioned. The idea is worthy of consideration.

The association has finally acted upon a suggestion long discussed and will undertake during 1906 two meetings, one in the summer at Ithaca, N. Y., the other in winter at New York City.

While the New Orleans meeting was small in numbers and somewhat expensive to individuals, it has been pronounced a decided success. The quality of the welcome to the south has been remarkably fine. Those attending believe that an unusual work has been done in the advancement of science and that, though the meetings will usually be necessarily small, the association should more frequently convene in the remoter and unvisited cities of the country.

The following affiliated societies held sessions in conjunction with the association:

The American Chemical Society.
The Botanical Society of America.
The Botanical Club of the Association.
The Association of Economic Entomologists.
The Entomological Club of the Association.
The American Mycological Society.
The Sigma Xi Honorary Scientific Society.

In accordance with its established policy the association encourages the great national societies to meet in connection with it. The paid officers of the association take charge of all matters of detail without charge to the societies. At New Orleans the number thus affiliating was much smaller than usual, but this was expected, because of the great distances of the centers of gravity of these associations from that place. Those few, however, which came south on this occasion with the association, will join in the conviction that they accomplished a genuine service in the advancement of science.

The first session of the fifty-fifth meeting of the American Association for the Advancement of Science was called to order in Temple Sinai, New Orleans, at 10 A.M., Friday, December 29, 1905, by the permanent secretary, Dr. L. O. Howard, who stated that retiring President Farlow was ill and would be compelled to remain in bed during the day, but expected to be well enough to deliver his address at 8 P.M. Dr. Howard then introduced President Calvin M. Woodward, who assumed the chair. President Woodward expressed his regret at the indisposition of Dr. Farlow and said they had met to receive a special word of welcome from the great state and city which were the hosts. It was a very great pleasure to him to call attention to the material and scientific progress which had been made in New Orleans.

Hon. Charles F. Buck, on behalf of Governor Blanchard, extended a most eloquent welcome. He said in part:

In the name of the people of the state of Louisiana, I welcome you and wish you godspeed to your deliberations. Our people are in a mood of worship in this regard. Through all the generations of the past has hung a dread, impenetrable shadow over our destiny. A mysterious disease which baffled human skill in its treatment and defied inquiry into its coming and going threatened all our hopes and expectations indefinitely. Science has lifted the shadow and unlocked the mystery. We look the future in the face with a new hope and an unshaken confidence. Your coming to us, so far away from the usual centers, just at this time, appeals to us like a voice of succor and a helping hand in a wilderness. The association thus suggested touches on the lines of the pathetic, and our thanks go out to you with our welcome.

Science, like art, has no country. What it produces it produces for the benefit of all mankind; yet we have reason to be proud of the achievements of American scientists, and we have confidence that you will accomplish great things in the future. We hope that your deliberations will be productive of good results; that the fifty-fifth session of your association held in the state of Louisiana may become memorable in its annals, not only in relation to its specific objects, but in its personal and social significance.

There must have been some other motive than the pursuit of your technical work in your coming to this far-off place; you could probably have done that so much better elsewhere—nearer home. We are bound and we are glad to recognize a human sentiment in the visitation here. We can not and we do not want to get away from the fact that we are compatriots, citizens of the great republic which stands for all that ennobles and dignifies mankind.

In this spirit, in the name of the people of Louisiana, I greet you, and while we wish the association a reunion which shall leave pleasant reminiscences and practical results in the great and infinite domain of its work, we hope that also a touch of sentiment may go with you, and, when you shall have finished your labors and returned to your homes and workshops, you will look back with pleasure to your visit to the south and remember with pleasure that you have been in the house of your friends and brothers, whose sincere prayers for happiness and success will go with you.

Mayor Martin Behrman, on behalf of the city, spoke briefly in part as follows:

We have set out on a progressive march and are pressing forward to a great commercial development for the attainment of which we are equipping ourselves with every modern device and facility. Chief among these are our systems of sewerage and drainage, as well as one for a supply of pure and healthful water, all of which are now in course of construction, as will be evidenced in the torn up and almost impassable condition of many of our thoroughfares. I have been informed that there are in your organization members who have made a special study of these undertakings. We most earnestly invite them to examine our work as far as it has been prosecuted. Arrangements have been made to facilitate them in this inspection. We want your suggestions and advice; we invite your criticism, knowing full well that anything you may have to say will proceed solely from your desire to insure our betterment and advancement.

I can assure you that our people appreciate highly the fact that among the great features of your deliberations in this convention is the section devoted to the discussion of these very subjects. We all feel that of the many important conventions which have been held in this city, this is really the most important. Its deliberations touch and treat upon so many subjects in which our people and our city are so vitally interested that your discussions will be listened to or read eagerly and accepted as authoritative. We are pleased sincerely that you have come among us, and as the chief executive of the city I deem it an honor to extend to you a most cordial welcome.

President E. B. Craighead, of Tulane University, extended a most friendly greeting to the visitors on behalf of the schools and colleges of New Orleans. He referred to the fact that here was located the first institution of learning for women established in this country, one hundred and fifty years ago—the Ursuline Convent. This was the home of John McDonough, who had made the largest bequest of any citizen to the public schools. It was also the home of Paul Tulane, who had made

the largest bequest to Tulane University, formerly the University of Louisiana, but which took his name in honor of its benefactor. It was the home of A. C. Hutchinson, who had left $800,000 to the medical department of Tulane University. It was the home of Mrs. Dr. T. G. Richardson, who had given $150,000 to the medical department of Tulane. It was the home of Mrs. Josephine Louise Newcomb, who had left $3,500,000 to the Newcomb College, the woman's branch of Tulane University, which would be the best endowed college for women in the world. He welcomed the visitors to the home of such philanthropists and hoped their deliberations here would be fruitful of much good.

President Woodward expressed the thanks of the association for the welcome. A year ago when the members were at Philadelphia there seemed to be but one thought and that was that they should all go to New Orleans. So they decided to come, and were here—at least a part of them were here—the cream, as it were, of the association. They represented every state in the union, and were devoted to their work. While they loved science for science's sake, they also loved it because of what it did for humanity. He was proud of the noble men and women of New Orleans who had done so much for education and science. They had built the noblest monuments to themselves. In St. Louis he had abundant evidence of the activity of the people of New Orleans and Louisiana, and recalled the reproduction of the Cabildo and other Louisiana buildings at the exposition. He was interested in two things in New Orleans. He was the intimate friend of the great engineer who built the Eades Jetties, and they together had studied and theorized over the problems presented by the work. He was glad to see that to-day, because of the success of that work, great ships were lying at the wharves in New Orleans. That was a work of science and an application of the law of physics. All that had to be done to control the greatest rivers was to understand these laws. He spoke of the yellow fever fight here, how manfully it was fought, and what a brilliant triumph it was. That also was the work of science.

He referred to Mr. Buck's remarks about the unity of the country, and said that he was glad to be here again. For he came here once before, some decades ago. On a train he and a gentleman from New Orleans got into conversation and exchanged their opinions of each other which they had held forty years ago, and agreed that if they had known each other then, as they knew each other now, there would have been no war. They were all here now in good fellowship; they were compatriots, and all working for the progress of science, and when they went back home they would take with them a mental picture of a thriving city on the banks of the Mississippi. In conclusion he announced that everybody was welcome to all the meetings of the sections, and he hoped the people of New Orleans who were interested in science would attend.

The general secretary, C. A. Waldo, then read an invitation from the sewerage and water board to inspect the public works in progress in New Orleans, with the names of a committee of five to facilitate such an inspection.

A resolution presented by Dr. Wm. Trelease, director of the Missouri Botanical Gardens, which had been favorably acted on by the council at the session in the morning, was presented to the general session for action. It related to the efforts to save Niagara Falls from destruction, and endorsed the stand taken by President Roosevelt. The resolution was adopted unanimously.

The following committees were appointed to serve during the meeting:

Committee on new members: The permanent secretary and secretary of the council.

Committee on fellows: The general secretary and the vice-presidents of the sections, Mr. Waldo, chairman.

Committee on grants: The treasurer and the vice-presidents of the sections, Mr. R. S. Woodward, chairman. In the absence of Mr. Woodward, the permanent secretary served in his place.

Mr. Theodore N. Gill was chosen auditor of the association.

After the first session of the council in St. Charles Hotel, all others were held daily, except Sunday, at Tulane University at 9 o'clock A.M. Two general sessions were held on the Friday and Wednesday following at 10 A.M. As in the previous year the vice-presidential addresses were scattered through the week.

The general program was as follows:

THURSDAY, DECEMBER 28, 1905.

Meeting of the executive committee of the council at St. Charles Hotel, 12 A.M.

Program for the entire meeting proofread and adopted.

Privileges of associate membership for the meeting extended to members of the local committee, residents of New Orleans and vicinity and to affiliated societies.

Mr. George E. Beyer, executive president of the local committee, outlined arrangements made by his committee for the meeting.

FRIDAY, DECEMBER 29, 1905.

Meeting of the council at 9:15 A.M., St. Charles Hotel.

In the enforced absence of the retiring president, Dr. Farlow, the incoming president, Dr. C. M. Woodward, presided without the usual formal introduction.

First general session of the association at 10 A.M. in Temple Sinai.

Meeting called to order by the permanent secretary, Dr. L. O. Howard, who introduced the president elect, Dr. C. M. Woodward.

Addresses of welcome by Hon. Chas. F. Buck, representing the governor of Louisiana, by Hon. Martin Behrman, mayor of New Orleans, and by Dr. E. B. Craighead, president of Tulane University.

Reply by President Woodward.

Announcements by the general secretary.

Adjournment of the general session, followed by the organization of the sections.

Sections A, B, C, D, E, F, at Tulane University, Section I in the Assembly Room, Board of Trade Building, Section K in Tulane University Medical College.

1 P.M. Luncheon to the members of the association, provided by the local committee in the refectory of the university.

Addresses of vice-presidents as follows: (At 2:30 P.M.)

Vice-president Ziwet before the Section of Mathematics and Astronomy, Gibson Hall. Title, 'On the Relation of Mechanics to Physics.'

Vice-president Kinnicutt, before the Section of Chemistry, Chemical Building. Title, 'The Sanitary Value of a Water Analysis.'

Vice-President Smith, before the Section of Geology and Geography, Gibson Hall. Title, 'On Some Post-Eocene and other Formations of the Gulf Region of the United States.'

Vice-president Merriam, before the Section of Zoology, Physical Building. Title, 'Is Mutation a Factor in the Evolution of the Higher Vertebrates?'

From 4 to 7 P.M. Mrs. T. G. Richardson received the association at her residence on Prytania Street.

At 8 P.M. the address of the retiring president of the association, Dr. W. G. Farlow, was given at Sophie Newcomb College. Subject, 'The Popular Conception of a Scientific Man at the Present Day.'

SATURDAY, DECEMBER 30, 1905.

Meeting of the council at 9 A.M., Gibson Hall, Tulane University.

Meeting of the sections at 10 A.M.

At 1 P.M. luncheon to the members of the association in the refectory.

At 2:30 P.M. addresses of vice-presidents as follows:

Vice-president Magie, before the Section of Physics, Physical Building. Title, 'The Partition of Energy.'

Vice-president Robinson, before the Section of Botany, Gibson Hall. Title, 'The Generic Concept in the Classification of the Flowering Plants.'

Vice-president Knapp, before the Section of Social and Economic Science, Board of Trade Building. Title, 'Transportation and Combination.'

At 8 P.M. the address of the retiring president of the American Chemical Society, Dr. F. P. Venable, Gibson Hall, Tulane University. Title, 'Chemical Research in the United States.'

At 9:30 P.M. general reception by the reception committee in the Palm Garden, St. Charles Hotel.

MONDAY, JANUARY 1, 1906.

Meeting of the council at 9 A.M.

Meeting of the sections at 10 A.M.

At 2:30 P.M. address of vice-president as follows:

Vice-president Jacobus, before the Section of Mechanical Science and Engineering, Gibson Hall. Title, 'Commercial Investigations and Tests in connection with College Work.'

At 8 P.M. public lecture complimentary to the citizens of New Orleans, at Sophie Newcomb College, by Elwood Mead, U. S. Department of Agriculture. Subject, 'Irrigation.'

At 9:30 P.M. meeting of the general committee, at St. Charles Hotel.

TUESDAY, JANUARY 2, 1906.

Meeting of the council in the assembly room, Gibson Hall, 9 A.M.

Meetings of the sections at 10 A.M.

Excursions to the Kenilworth Sugar Plantation and to the power plants and pumping stations and sewerage plants of New Orleans.

At 6:30 P.M. banquet of the Sigma Xi at Antoine's.

WEDNESDAY, JANUARY 3, 1906.

Meeting of the council, Gibson Hall, 9 A.M.

Closing general session, Gibson Hall, 10 A.M.

Trolley ride to all points of interest complimentary to members of the association, at 3 P.M.

The courtesies and privileges of the Boston Club, the Pickwick Club, the Chess, Checkers and Whist Club, the Young Men's Gymnastic Club, the Country Club and the Round Table Club were extended to members of the association during their stay in New Orleans.

REPORTS OF COMMITTEES.

On the Study of Blind Invertebrates.

Mr. A. M. Banta continued his work on the fauna of Mayfield's cave during last winter and through the entire summer. I have passed on his paper 'Mayfield's Cave as a Unit of Environment and the Ecological Relation of its Inhabitants,' which is now ready for the printer. It is a unique and comprehensive work on the fauna of this cave. The work was completed without calling on the appropriation made at the last meeting for the work of the committee.

It was the plan to have Mr. Banta visit the region in Pennsylvania where Professor Cope, years ago, secured his blind catfish which has not been found again. The finishing of his Mayfield Cave paper delayed him so that he was not able to do this before going to Harvard University, where he holds a fellowship. He is at present at Harvard, working on the reactions of cave animals. Live specimens have been sent him from time to time.

Mr. Banta will visit How's Cave in central New York during this week. This cave being in the glaciated region ought to have a much newer fauna than the Indiana, Kentucky and Missouri caves, all of which are south of the drift region.

For unavoidable reasons I have not been able to go into the field myself.

The entire appropriation made for this work at the last meeting of the association is available for the future work of your committee.

Respectfully submitted,
(Signed) C. H. EIGENMANN,
Recorder.

REPORT OF COMMITTEE ON ELECTROCHEMISTRY.

A study has been made of the behavior of platinum and iridium in chlorine water and in dilute hydrochloric acid. Smooth platinum foil brought about no evolution of gas even after standing 168 hours in chlorine water. Under precisely similar circumstances an iridium foil caused an evolution of 44.4 of gas, 55 per cent. of which was oxygen. The oxygen results from the reaction

$$Cl_2 + H_2O = 2HCl + O,$$

while the chlorine came from the solution, the original vapor pressure having been about half an atmosphere. This series of experiments showed that iridium was a more powerful catalytic agent than platinum. A number of electrolytic experiments were made with hydrochloric acid of different concentrations. In all cases more oxygen was evolved from the iridium anode than from the platinum anode. The question as to the final equilibrium is still in doubt.

It was hoped that a tantalum anode could be secured for this work, but this proved impossible and the money appropriated for the year 1905 was not drawn from the treasury. The committee asks that this unexpended balance be left available for the coming fiscal year.

WILDER D. BANCROFT,
EDGAR F. SMITH,
L. KAHLENBERG.

Verbal reports of progress were made by the committees on 'The Relation of Plants to Climate' and of 'Anthropometric Measurements.'

GRANTS.

$200 were allotted by the committee on grants to Messrs. Parsons, Kinnicutt and Venable to assist in the publication of Professor Parson's 'Bibliography of Beryllium.'

$100 were allotted to 'The Concilium Bibliographicum Zoologicum.'

RESOLUTIONS.

Preservation of Niagara Falls.

As has been well said by President Roosevelt in his message to the fifty-ninth congress, 'there are certain mighty natural features of our land which should be preserved in perpetuity for our children and our children's children.' Chief among these natural wonders in the east is Niagara Falls, the continuance of which as a scenic feature is now seriously threatened by the use of the water for the production of electric power. Authorities agree that grants to existing corporations for power purposes will, when the now rapidly proceeding work of development is completed, entirely destroy the American fall, also making useless the magnificent New York State Reservation which has so well preserved the natural beauty of the cataract's surroundings.

President Roosevelt further suggests that if the state of New York can not promptly take action to avert this impending calamity, 'she should be willing to turn it over to the national government, which should in such case (if possible, in conjunction with the Canadian government) assume the burden and responsibility of preserving unharmed Niagara Falls.'

THEREFORE BE IT RESOLVED That the American Association for the Advancement of Science hereby records its hearty concurrence in these suggestions of President Roosevelt, and instructs its president and secretary to communicate to the president of the senate and to the speaker of the house of representatives of the United States its strong conviction that Niagara Falls should be preserved as a natural wonder, and further expressing the earnest hope that the congress now in session will take prompt and energetic action looking toward an international consideration of the impending danger to Niagara Falls. And further, be it

Resolved, That each member of the American Association for the Advancement of Science is hereby urged to write to the senators and congressmen of his own state, earnestly favoring immediate action for the preservation of Niagara Falls.

An Appalachian Forest Reserve.

Resolved, That the American Association for the Advancement of Science, now in session at the city of New Orleans, again respectfully calls attention to the rapid rate at which the forests of the Appalachian Mountain region are being destroyed, and to the fact that, as a result of such destruction, the streams tributary to the Missisippi, as well as those flowing into the south Atlantic, are becoming continuously more irregular in their flow, and hence of less value for navigation and power purposes.

Resolved, That the association, therefore, respectfully petitions the congress of the United States to make such provision as may be necessary for the protection of these mountain forests, and directs that copies of these resolutions be transmitted to the honorable, the secretary of agriculture, and to the honorable, the speaker of the house of representatives.

The above resolution was unanimously approved by Section G, American Association for the Advancement of Science, at the meeting of December 30, 1905; also reported recommended by Section I.

AMENDMENTS.

The following amendments to the constitution were proposed and are to be acted

upon at the New York meeting, having been duly read at the last general session of the New Orleans meeting:

1. Add the words 'and Psychology' to the name of Section H, making it read 'Anthropology and Psychology.'

2. Add a new section, to be called Section L—Education.

POLICY OF THE ASSOCIATION.

In accordance with the resolution adopted by the last Philadelphia meeting through which a number of national scientific societies were accepted as having qualifications for membership equal to the qualifications for fellowship in the American Association, several hundred members from these societies were in the usual way made members of the American Association, were then nominated for fellowship and were electec by the council.

The committee on policy presented the following resolutions which were adopted by the council:

1. *Resolved,* That the terms of office of all officers of the association shall begin with the close of the meeting at which the elections take place.

2. *Resolved,* That the position of second assistant to the permanent secretary be abolished at the close of the year, 1906.

3. *Resolved,* That an invitation be extended to the National Association for the Scientific Study of Education to affiliate with the American Association on the same terms as other affiliated societies.

CLOSING GENERAL SESSION 10 A.M. WEDNESDAY.

The report of the general secretary was read. Resolutions of thanks and appreciation unanimously adopted as follows:

Resolved: That the appreciative thanks of the American Association for the Advancement of Science be, and they are, hereby extended

1. To President Craighead and the board of trustees of Tulane University for the provision of ample and adequate meeting places for most of the sections in the University buildings; further to Dr. Chaillé and Dr. Metz for the excellent provision made for the Section of Physiology and Experimental Medicine in the medical school of the university; to the board of trade for the use of its building, granted to the Section of Social and Economic Science through the interest of Secretary Mayo, of the New Orleans Progressive Union; to Rabbi Heller and the Congregation of Temple Sinai for the use of that building for the opening session, and to Professor Dixon for having the auditorium of the H. Sophie Newcomb College opened for the address of the retiring president of the association, and other purposes.

2. To Professors Craighead and Anderson and their associates in the committee on meeting places and equipment for their provision of appliances, lantern service and other necessaries for the meetings.

3. To the sewerage and water board for enabling the Section of Mechanical Science and Engineering to inspect the sanitary improvements now under way in the city; to the officials of the United States Navy Yard for courtesies shown to the same section; to the dock commissioners for exhibiting the shipping facilities of the port to the Section of Social and Economic Science; to Mr. Charles Farwell and Dr. Dyer for a demonstration of the workings of the large sugar estate of the former; and to Professor Blouin and Dr. Brown for having the further privilege accorded the visiting chemists and others to inspect the Kenilworth Sugar Plantation.

4. To the Boston Club, the Pickwick Club, the Chess, Checkers and Whist Club, and the Young Men's Gymnastic Club, the Country Club and the Round Table Club, for extending the privileges of their houses to all members of the association.

5. To the Round Table Club for a general smoker; to the Louisiana Society of Naturalists for an informal reception given to the visiting botanists and zoologists; to Mrs. T. G. Richardson, whose home was hospitably opened; and to the many other citizens of New Orleans and its vicinity whose welcome was so admirably expressed by Mr. Buck on behalf of the governor of the state, by Mayor Behrman and President Craighead, and who, in one way or another, have made our visit pleasurable, without interfering with the more serious purposes of the association and affiliated bodies.

6. To the very efficient press committee and representatives of the newspapers, who have treated our proceedings with unusual interest, intelligence and care, thus furthering the general purposes of the association, and at the same time

promoting local interest in pure and applied science.

Finally, and in the most comprehensive sense, to the local committee and especially to its presidents, Drs. Craighead and Beyer, its secretary, Mr. Mayo, and the chairman of its finance committee, Mr. Godchaux—in addition to the courtesies already mentioned—for providing ideal lunch arrangements, so convenient to the meeting places as to avoid a wasteful break in the day's work; for tendering a delightful reception—the peculiar charm of which was due in large part to the tactful management of Miss Minor and her associates in the ladies' reception committee; for a final ride, enabling us to carry away a coherent impression of New Orleans and its many points of historic interest; and for many acts of thoughtfulness—individual as well as collective—that will cause the past week to remain among the most pleasant memories that cluster about the many pleasant meetings of the association.

(Signed) WILLIAM TRELEASE, Chairman,
For the Committee,
Messrs. Trelease, Magie and Newcomb.

Response to these resolutions and farewell were given for the local committee by Professor Geo. E. Beyer, who extended a cordial invitation to the association to meet soon again in New Orleans. Response by President Woodward, who was also formally thanked by the association for his efficient and acceptable work as presiding officer. Adjourned.

GENERAL COMMITTEE.

At the meeting of the general committee on Monday evening, January 1, 1906, it was decided to hold a special summer meeting at Ithaca, New York, to close on or before July 3, 1906, and a regular winter meeting in New York City to begin on Thursday, December 27, 1906. The presidential and vice-presidential addresses will be omitted at the summer meeting and given at the winter meeting.

The officers elected at the New Orleans meeting will, therefore, hold over to the close of the New York meeting. Chicago was recommended as the place of the winter meeting of 1907.

The following officers were elected for the Ithaca and New York meetings:

President: Dr. W. H. Welch, Baltimore, Md.

Vice-Presidents:

Section A—Dr. Edward Kasner, New York City.

Section B—Professor W. C. Sabine, Cambridge, Mass.

Section C—Mr. Clifford Richardson, New York City.

Section D—Mr. W. R. Warner, Cleveland, O.

Section E—Professor A. C. Lane, Lansing, Mich.

Section F.—Professor E. G. Conklin, Philadelphia, Pa.

Section G—Dr. D. T. MacDougall, Washington, D. C.

Section H—Professor Hugo Münsterberg, Cambridge, Mass.

Section I—Mr. Chas. A. Conant, New York City.

Section K—Dr. Simon Flexner, New York City.

General Secretary: Mr. John F. Hayford, Washington, D. C.

Secretary of Council: President F. W. McNair, Houghton, Mich.

CLARENCE A. WALDO,
General Secretary.

THE RELATION OF MECHANICS TO PHYSICS.[1]

IN the historical development of mechanics the names of Galileo, Newton and Lagrange mark the principal epochs, each of the three periods, from Galileo to Newton, from Newton to Lagrange and from Lagrange to our time, covering roughly a century.

When Galileo in 1633, at the age of sixty-nine years, was forced by the prelates of Rome to abjure solemnly the truth of the Copernican system of the universe to the proof of which he had devoted the main efforts of a long and active life, he had still to write his most remarkable work, the 'Discorsi e dimostrazioni mate-

[1] Address of the vice-president and chairman of Section A, Mathematics and Astronomy, of American Association for the Advancement of Science, New Orleans, December 29, 1905.

matiche intorno à due nuove scienze attenenti alla mecanica et i movimenti locali' (1638).[2] He composed it while confined to a house at Arcetri, near Florence, under the close watch of the Inquisition, strictly forbidden to publish anything and struggling with ill-health and the infirmities of old age which were soon to deprive him completely of his eyesight. Considering these circumstances of its composition, the marvelous freshness and wealth of ideas of this work, which makes Galileo the first mathematical physicist, would be incomprehensible if we did not know from his correspondence that the materials for it had largely been in his mind ever since his early youth. If this be taken into account, the beginnings of both mechanics (apart from statics) and mathematical physics may be dated back to about the year 1600.

One of the two new sciences originated by Galileo in the 'Discorsi' is mechanics as the science of motion, especially in its application to falling bodies and projectiles. The genius of Newton, of Huygens, of Leibniz, was soon to prove the correctness of Galileo's prophetic insight in claiming for his speculations on motion the name of a new science. What Newton and his followers in the eighteenth century did for mechanics is too well known to be here rehearsed. By his careful formulation of the fundamental postulates and definitions and by his bold assumption of the law of universal gravitation, Newton laid the lasting foundations for astronomical mechanics; and his fluxional calculus opened up for this science a wide range of development.

The other of Galileo's two new sciences deals with the internal structure of matter and the so-called resistance of materials; it is the germ of the mechanics of deformable bodies. Progress along this line proved a far more difficult task. The seventeenth and eighteenth centuries contributed but little to the theory of elasticity. Indeed, a new mathematical tool, the theory of partial differential equations, had to be invented, and a physical phenomenon hitherto neglected, vibratory and wave motions, had to attract the attention of mathematicians, before the mechanics of deformable bodies could become a true science. Besides, the conception of mechanics itself had to be broadened; and this was accomplished by Lagrange in his 'Mécanique analytique' (first edition 1788, second edition 1811–15).

In view of the use made in the course of the nineteenth century of Lagrange's generalizations (it may suffice to mention the theory of the potential, the Lagrangian equations of motion with their generalized idea of force, the general 'principles' such as the principle of least action) it is, I believe, not too much to say that Lagrange's work is as great an advance on Newton's as Newton's was on that of Galileo.

By the contemporaries of Lagrange this advance was perhaps not fully appreciated. We find the physicists of the beginning of the nineteenth century still very strongly attached to the idea that all natural phenomena not only may, but must, be explained on the basis of Newton's laws[3] by central forces acting instantaneously at a distance. Newton's mechanics had done such admirable service in astronomy that

[2] It is to be regretted that there exists no good modern translation of this classical work. The German translation published in *Ostwald's Klassiker der exakten Wissenschaften* (Nos. 11, 24, 25), while it contains some helpful notes, is not always exact and trustworthy. The original has recently been edited with great care by A. Favaro in Vol. VIII. (1898) of the 'national edition' of Galileo's Works.

[3] See, however, Laplace, 'Mécanique Céleste,' livre I., Chap. VI. ('Oeuvres,' Vol. I., 1878, pp. 74–79), a passage to which E. and F. Cosserat have recently called attention.

it had come to be regarded as the only possible means of describing and discussing the actions of nature. The gradual abandonment of this position and the change to the modern view according to which all actions in nature are transmitted through a continuous medium and require time for their transmission was accomplished only after a long struggle that occupied the greater part of the nineteenth century.

The more or less conscious part taken in this struggle by *technical* mechanics, which in the same period developed into a science, has not always been insisted upon sufficiently. Technical mechanics has always been free of the idea of central forces. To the engineer the idea of forces acting at a distance is completely foreign, in spite of the curious fact that, until not so very long ago, the typical example of such a force, gravitation, was almost the only force with which he had to deal. The development of thermodynamics, which has given us the principle of the conservation of energy in its broadest aspect, was closely connected with the rise of technical mechanics, but proceeded rather independently of the development of the other branches of mathematical physics. Its fundamental principles are of a very general and abstract nature, and even where the molecular hypothesis is well worked out, as in the kinetic theory of gases, the idea of central forces is in no way essential.

Hydrodynamics, elasticity, optics, electricity and magnetism, though originally based on molecular hypotheses and the idea of central forces, in the course of their development found themselves more or less independent of these notions. In all of them the important common feature is the propagation of actions through a medium which can be regarded, at least in first approximation, as continuous. In hydrodynamics and in the theory of elasticity this medium is that unknown something which we call matter; in optics, and later in the theory of electricity and magnetism, it was found necessary to postulate the existence of another medium, the ether.

It is well known how the ideas of Faraday, of Maxwell, of Hertz, gradually gained ascendency over the older views and led to the abandonment of the idea of central forces acting instantaneously at a distance, in almost all branches of physics except in the theory of gravitation. It is also known that Maxwell, by a brilliant analysis, succeeded in establishing the connection between his electromagnetic theory and the analytical mechanics of Lagrange. Thus, at the end of the nineteenth century we find a general attitude toward physical phenomena essentially different from that prevailing at the end of the eighteenth century.

With the rise of the electron theory in the course of the last twenty-five years a new element has been introduced into this development, an element which seems destined to affect very radically not only our interpretation of physical phenomena, but also our general views about the principles of theoretical mechanics. The idea of the electron has grown out of the idea of ions as used in electrolysis. Each molecule of an electrolyte may break up into two ions, *i. e.*, two atoms, or groups of atoms, carrying equal and opposite charges. The current passing through the electrolyte then consists in the actual transfer of these ions to the cathode and anode to which they give up their charges. In his Faraday lecture, delivered in 1881, which marks an epoch in the ion theory, Helmholtz says: "If we accept the hypothesis that the elementary substances are composed of atoms, we can not avoid concluding that electricity also, positive as well as negative, is divided into definite elementary portions, which behave like atoms of electricity."

These 'atoms of electricity,' since en-

countered in a large number of more recondite phenomena, and often apparently free, *i. e.*, not attached to any matter in the ordinary sense, are the *electrons*. Thus physicists have been led to return in a certain sense to atomistic conceptions, without however, abandoning the idea of the propagation of electric, magnetic and optical disturbances through the ether in time. Lord Kelvin, in his Baltimore lectures in 1884, gave expression to this tendency so largely developed in the succeeding twenty years. The very first words of his first lecture are: "The most important branch of physics which at present makes demands upon molecular dynamics seems to me to be the wave theory of light."

Without discussing the experimental basis of the electron theory it must here suffice to say that on the one hand the dispersion and diffraction of light, on the other the phenomena exhibited by cathode and canal rays, Röntgen rays, the Becquerel rays emitted by radium, etc., all find their ready interpretation in this theory.[4] At the same time, the electron theory as developed by Lorentz, Wiechert, Drude and others seems to furnish an excellent basis for the whole theory of electricity, magnetism and light.[5] Indeed, attempts have already been made of interpreting matter itself as an electromagnetic phenomenon and of explaining gravitation by means of this electron theory of matter.

[4] See, for instance, W. Kaufmann, *Physikalische Zeitschrift*, 3 (1901), pp. 9 sq., translated in *The Electrician*, 48 (1901), pp. 95–97; O. Lodge, *Journal of the Institute of Electrical Engineers*, 32 (1902–3), pp. 45–115; P. Langevin, *Revue générale des sciences*, 16 (1905), pp. 257–276; H. A. Lorentz, 'Ergebnisse und Probleme der Elektronentheorie,' Berlin, Springer, 1905.

[5] It will be sufficient to mention Lorentz's articles in the *Encyklopädie der mathematischen Wissenschaften*, V., 13, 14, where full references are given, and to the systematic work of M. Abraham, 'Theorie der Elektrizität,' I. (1904), II. (1905), Leipzig, Teubner.

It should be observed that the electron theory does not upset that beautiful structure known as the electromagnetic theory of Maxwell and Hertz. It merely modifies it to a certain extent so as to give a more detailed account of electromagnetic phenomena in ordinary matter. It is related to the older theory somewhat as the kinetic theory of gases is related to the theory of heat and of ordinary matter in general. The kinetic theory assumes the laws of ordinary mechanics for the motion of the hypothetical molecule and then tries to determine the average effects arising from the motion of very large numbers of such molecules, these averages being the only thing actually observable. Similarly the electron theory must begin with postulating laws of motion for the single electron in the electromagnetic field and try to deduce the average effects due to swarms of electrons; the comparison of these calculated average effects with the results of observation and experiment must serve as verification of the postulated laws.

If, then, observation leads us to the assumption that electric charges may exist and move about without being attached to, or carried by, ordinary matter, what are the 'laws of motion' of such an electron? As the moving object is not ordinary matter we must not be astonished to find that Newton's laws of motion can not be applied blindly. The electron moves according to the laws of electrodynamics. We are thus confronted with the question as to the relation of the fundamental postulates of this science to those of ordinary mechanics.

An electric charge at rest manifests its presence only by the field which it excites in its vicinity, by the sheaf of lines of force issuing from it. To take a simple concrete example, a small charged sphere has lines of force radiating as if from its center in all directions, and the electric force, or intensity of the field, **E**, at any point *P*, at

the distance r from the center of the sphere whose charge is e, has the direction of r and the magnitude e/r^2.

If the sphere is in motion it carries its field along almost unaltered, provided the velocity $\mathbf{v}$ of the sphere be small in comparison with the velocity of light. But it excites a magnetic field, the magnetic force, or intensity, being $\mathbf{H} = \mathbf{E} \times \mathbf{v}$; *i. e.*, the magnitude of the force at P is $= ev \sin(\mathbf{E}, \mathbf{v})/r^2$, its direction is at right angles to $\mathbf{E}$ and $\mathbf{v}$, and its sense is such that the three vectors $\mathbf{E}$, $\mathbf{v}$, $\mathbf{H}$ form a right-handed set. The lines of magnetic force are, therefore, coaxial circles about the direction of motion.

According to the electromagnetic theory, the energy of the magnetic field is distributed throughout the field, with volume density $(1/8\pi)\mu\mathbf{H}^2$, where μ is the magnetic permeability of the medium. The energy of the whole field is readily obtained by integrating over the space outside the sphere; it is found $= \frac{1}{3}\mu e^2 v^2/a$, where a is the radius of the sphere. This magnetic energy, being due to the motion of the charge, is analogous to kinetic energy.

If the charged sphere consists of an ordinary mass m carrying the charge e so that its ordinary kinetic energy is $\frac{1}{2}mv^2$, the total kinetic energy due to the motion of m and e with the velocity v is

$$T = \tfrac{1}{2}\left(m + \tfrac{2}{3}\mu\frac{e^2}{a}\right)v^2,$$

that is, the same as if the mass m of the sphere were increased by the amount $\frac{2}{3}\mu e^2/a$.

The result, then, is similar to that known in hydrodynamics for a sphere of mass m moving through a frictionless liquid. In moving, the sphere sets the surrounding liquid in motion; to move the sphere we have to set in motion not only the mass m, but also that of the liquid around it. Thus the sphere moves in the liquid just as a sphere of greater mass would move in vacuo. In the case of a sphere the mass is increased by one half of that of the liquid displaced. But in the case of a body whose mass is not distributed as symmetrically as in the case of the sphere the mass to be added depends on the direction of motion.

As the apparent mass of the charged sphere in motion, owing to the presence of the charge e, exceeds the ordinary mass m by $\frac{2}{3}\mu e^2/a$, the apparent momentum exceeds the ordinary momentum mv by $\frac{2}{3}\mu e^2 v/a$; and this additional momentum must be regarded as residing not in the sphere but in the surrounding field. This momentum possessed by the field is what Faraday and Maxwell used to call the electrotonic state.

In the case of the free electron we have $m = 0$; hence the total mass, momentum, kinetic energy, is magnetic and is distributed throughout the field. Moreover, if the velocity of the electron be comparable with the velocity of light, the apparent mass will depend not only on the direction, but also on the magnitude of this velocity.

Any variation in the velocity of the charged sphere, or of the electron, produces a variation in the momentum of the field, which is propagated as a pulse through the field with the velocity of light. If such a pulse strikes a charged body at rest, the body acquires velocity and momentum, the momentum acquired being equal to that lost by the pulse. As the pulse resides in the ether, the law of the equality of action and reaction would make it necessary to assume an action exerted on the ether itself. In the electron theory of Lorentz which does not admit such actions on the ether Newton's third law of motion is violated in as much as action and reaction take place neither at the same place nor at the same time.

These very brief and incomplete indications will perhaps suffice to call to mind

some of the characteristic differences between the fundamental principles of ordinary mechanics and the modern electromagnetic theory. Is it necessary, then, to keep these two sciences distinct, or is it possible to build them up on a common foundation? Such a common foundation is certainly desirable; and it will ultimately amount to the same whether we try to generalize the principles of mechanics so as to embrace the electromagnetic theory, or whether we follow W. Wien[6] in deducing the principles of mechanics as a particular or rather limiting case from Maxwell's equations.

The question can be put in a somewhat different form. There seem to be two things underlying all the phenomena in the physical world: the ether and matter. To attain the unification of physical science, shall we consider the ether as a particular kind of matter? Or shall matter be interpreted electromagnetically? The older mechanics dealt exclusively with matter; and when it first became necessary to introduce the ether, this new medium was often endowed with properties very much like those of matter. The hydrodynamic analogy by which the apparent mass of the moving charge was interpreted above illustrates this tendency. The physics of the ether has, however, reached so full a development that the properties of the ether are now known far more definitely than those of matter. These properties are contained implicitly in the fundamental equations of Maxwell and Hertz which in their essential features are adopted in the electron theory of Lorentz.

In this theory the electromagnetic mass of the electron is nothing but the self-induction of the convection current produced by the moving electron. This mass depends on the velocity of the electron, or rather on the ratio of this velocity to that of light. Moreover, this mass, or inertia, may be of two kinds: longitudinal, as opposing acceleration in the direction of motion, and transverse, as opposing acceleration at right angles to the path. Any variation in the velocity is transmitted as a radiation through the ether with the velocity of light.

The electromagnetic energy does not reside in the moving electron, but is distributed through the whole field, with the volume density $(1/8\pi)(\mathbf{E}^2+\mathbf{H}^2)$, if $\mathbf{E}$ and $\mathbf{H}$ are the electric and magnetic vectors of the field. In determining the rate of work in any region we must take into account not only the time-rate of change of this energy in the region, but also the flux of energy through its boundary, which has the value $(c/4\pi)\ \mathbf{E}\times\mathbf{H}$, per surface element, c being the velocity of light.

M. Abraham[7] has shown that the fundamental equations of Lorentz's theory of electromagnetism can be given a form that bears a striking resemblance to the fundamental equations of ordinary mechanics. But he has pointed out at the same time that in spite of this analogy of mathematical form the real meaning of the equations is essentially different from their meaning in the older mechanics. The underlying invariant quantity is not ordinary mass, but the electric charge of the electron; mass, or inertia, is variable, depending on the velocity; momentum and energy are distributed through the field; the flux of energy, given by Poynting's radiation vector, is essential in determining the rate of working of a system. All these differences are ultimately due to the modern conception of the propagation of all actions, not instantaneously, but in time, through a medium. This idea, as seems to

[6] Ueber die Möglichkeit einer elektromagnetischen Begründung der Mechanik, *Archives néerlandaises* (2), 5 (Lorentz Festschrift), 1900, pp. 96–107.

[7] *Annalen der Physik*, Vol. 10 (1903), pp. 105–179.

have been foreseen long ago by Gauss[8] and Riemann,[9] requires a generalization of, or even a direct departure from, the ordinary laws of mechanics: the law of the relativity of motion, the conservation of linear and angular momentum and of energy in a closed system, the instantaneous equality of action and reaction.

It is now pretty generally recognized that Newton's 'laws of motion,' including his definition of 'force,' are not unalterable laws of thought, but merely arbitrary postulates assumed for the purpose of interpreting natural phenomena in the most simple and adequate manner. Unfortunately, nature is not very simple. "As the eye of the night-owl is to the light of the sun, so is our mind to the most common phenomena of nature," says Aristotle. And if since Newton's time we have made some progress in the knowledge of physics it is but reasonable to conclude that the postulates which appeared most simple and adequate two hundred years ago can not be regarded as such at the present time.

This does not mean, of course, that the mechanics of Newton has lost its value. The case is somewhat parallel to that of the postulates of geometry. Just as the abandonment of one or the other of the postulates of Euclidean geometry leads to a more general geometry which contains the old geometry as a particular, or limiting, case, so the abandonment or generalization of some of the postulates of the older mechanics must lead to a more general mechanics. The creation of such a generalized mechanics is a task for the immediate future. It is perhaps too early to say at present what form this new non-Newtonian mechanics will ultimately assume. Generalization is always possible in a variety of ways. In the present case, the object should be to arrive at a mechanics, on the one hand sufficiently general for the electron theory, on the other such as to include the Newtonian mechanics as a special case.

After the searching criticism to which Poincaré, especially in his St. Louis address,[10] in 1904, has subjected the foundations of mechanics and mathematical physics, almost the only one of the fundamental principles that appears to remain intact is the principle of least action. It seems, therefore, natural to take this principle as the starting point for a common foundation of mathematical physics and of a generalized mechanics, but with a broader definition of 'action,' or what amounts to the same, with a generalized conception of 'mass' so as to make the latter a function of the velocity.

A very notable attempt has recently been made in this direction by E. and F. Cosserat.[11] And although only a first instalment of their investigation has so far been published, the able way in which the difficult problem is here attacked seems full of promise for a solution as complete as the nature of the case may warrant.

It may, perhaps, be said that, in demanding a generalization of the foundations of mechanics on such broad lines, I have attached undue importance to the electron theory as developed by Lorentz and Abraham, a theory which is still in the formative stage. There exist electromagnetic theories that appear less radical in their departures from the older views

[8] Gauss, Werke, Vol. 5, p. 627. Compare *Encyklopädie der mathematischen Wissenschaften*, Vol. 12, pp. 45–46.

[9] Riemann, Werke, 2d edition, 1892, p. 288.

[10] *Bulletin des sciences mathématiques* (2), 28, pp. 302–324; English translation in the *Bulletin of the American Mathematical Society*, Vol. XIII., February, 1906.

[11] *Comptes rendus*, Vol. 140, pp. 932–934; for a more detailed development see the notes contributed by E. and F. Cosserat to the French translation of O. D. Chwolson's 'Traité de physique,' Paris, Hermann, 1905.

and not so much open to the objection of violating long established principles. But if I have insisted particularly on the theory of Lorentz, it was just for the purpose of bringing out as clearly and forcibly as possible the differences between the old and the new.

Besides, there is one minor feature in the form of presentation adopted by Lorentz and Abraham which appeals to me as worthy of attention: it is the consistent use of the vector analysis of Gibbs and Heaviside. And perhaps this is really somewhat more than a mere matter of form. Burkhardt[12] has shown that this vector analysis has a rational mathematical basis. And after the numerous and manifold applications that have been made of this method its usefulness can no longer be questioned. The diversity of notations used by different authors can hardly be regarded as a serious objection. Have we not a large variety of notations even in so old and well-established a branch of mathematics as the differential calculus? The important thing about vector analysis is that it teaches to think in vectors and fields. E. Picard,[13] in a lecture, has recently called attention to the importance of the field even in ordinary elementary mechanics. A. Föppl has led the way in using vector symbols in an elementary treatise on technical mechanics.

Vector addition is now more or less familiar even to the student of the most elementary mechanics, largely owing to the influence of graphical statics. Is it not time to introduce at least the scalar and vector products and the time-differentiation of vectors in the mechanics of the particle and the rigid body? The gain in clearness and conciseness in stating the more general propositions is certainly great. In the mechanics of deformable bodies and media (hydrodynamics, elasticity), the general theory of vector fields, with the fundamental notions of divergence and curl, flux and flow, lamellar and solenoidal fields, etc., should surely form the preliminary mathematical basis for all further study; and here the simple symbolism of vector analysis is particularly well adapted to the subject.

But whatever may be the form of presentation selected, the study of the fields of scalars, vectors and higher point functions, so intimately connected with the modern views of physical phenomena, might well claim more attention on the part of the pure mathematician than it has so far received.

Alexander Ziwet.

[12] *Mathematische Annalen*, Vol. 43 (1893), pp. 197–215.

[13] 'Quelques réflexions sur la mécanique, suivies d'une première leçon de dynamique,' Paris, 1902.

THE SANITARY VALUE OF A WATER ANALYSIS.[1]

Twenty years ago, the vice-president of this section, the late Professor William Ripley Nichols, took as the subject of his address, 'Chemistry in the Service of Public Health,' saying: "If any are inclined to criticize my choice of that branch of applied chemistry with which I am most familiar, I trust they will consider that, after all, few of us have the opportunity, or, let us confess it, the ability to carry research and speculation to the height to which chemistry is capable of rising." Agreeing fully in the sentiment of this last sentence, though not at all as applying to Professor Nichols, whose marked ability as an investigator was recognized by all, I feel that I can best fulfill the clause in our constitution which requires the several vice-presidents to give an address before their

[1] Address of the vice-president and chairman of Section C, Chemistry, American Association for the Advancement of Science, New Orleans, December, 1905.

respective sections, by taking for my address a subject that does not call for the speculative thought of theoretical chemistry, but rather the careful consideration of some one subject in my own field of work. I have, therefore, chosen as my topic 'The Sanitary Value of a Water Analysis.'

A question of great importance to a community is the character of its water supply, and of equal importance to the individual is the purity of the water that is used in his household, whether it comes from a city main, or an isolated well in the country. That this was not always so considered hardly requires mention, for it is not a great many years since disease was considered a direct visitation of providence. The first investigation that attracted public attention to the fact that there might be a connection between the use of polluted water and disease may be said to be what is known in sanitary science as the 'Broad Street Well Investigation.' In the epidemic of cholera in London in 1854, the parish of St. James, Westminster, which in previous epidemics had suffered, on the whole, less than many other parts of London, suffered most severely, the death rate reaching two hundred in ten thousand. The whole parish was not equally affected, and the center of infection, or the special cholera area was in the neighborhood of Broad Street, and attention was drawn to the fact that, though city water was supplied to this district, a well situated on Broad Street was used to a very large extent for household purposes. An investigation followed and it was shown that of the deaths that occurred during the first week of the outbreak among persons living in this neighborhood, 82 per cent. were known to have used the water from this well, and that houses and factories in the same radius where the water from this well was not used seemed to be exempt from the disease.

A strong case between cause and effect was thus made out, and when a subsequent examination showed that there was direct leakage from an open privy into this well, it established as clearly as could be done by circumstantial evidence that the epidemic in St. James parish in 1854 was caused by polluted water.

A further striking proof that sewage polluted water may become the effective vehicle of the actual poison of disease was furnished through the cholera epidemic in London in 1866, but the theory that water is one of the most dangerous carriers of infection of cholera and of typhoid fever may be said to date from 1872, and to have been the result of the careful investigation of the typhoid fever epidemic in that year in Lausen, Switzerland. To-day we recognize as one of the best established theories of sanitary science that both cholera and typhoid fever are water-borne diseases, and that the primary cause of the large death rate from typhoid fever is due to the use of polluted waters.

The late Professor Thomas M. Drown divided all waters into two classes, namely, normal and polluted waters, and stated, as regards normal waters, that although they differ very widely in character from the pure colorless mountain brook to the dark-colored water from swampy ground, they are all characterized by never having received any contamination connected with man, and although often far from pure waters, differ from a polluted water in one most important respect, in that they are not capable of producing, as far as known, any specific germ disease.

It is true that many normal waters, on account of the large amount of vegetable matter they contain, are unfit for household use, although they may be sanitarily safe waters in the sense of not being the

vehicle of the germs of disease. Hence the sanitary value of a water analysis depends not on determining the amount of organic matter which a water contains, but on the amount of information it can give in answer to the question, 'Is a given water a normal or a polluted water?' or, stated in other words, 'How far can analysis determine whether or not the organic matter in a water is of vegetable or animal origin?'

In order to answer this question it is necessary to divide natural waters into three classes: Surface, subsoil or ground, and artesian waters. These waters differ so radically in character from each other that, although the data from which deductions can be drawn as regards pollution are practically the same, yet the correct interpretation of these data depends upon the knowledge as to which group the water in question belongs, and a clearer idea of the subject under discussion can be obtained if we first consider surface waters and apply the results of this study to ground and artesian waters.

It is often claimed that there is no value in a sanitary analysis of a surface water, that an inspection of the watershed may give all, and often much more, information than can be obtained from the analysis of the water. If sewage is seen to be entering a pond, an analysis is unnecessary to show that it is polluted. If the watershed is uninhabited, the water can not be polluted.

There is no question about the value of a survey and that a survey not only aids in drawing the proper deductions from the data of an analysis, but that often it is necessary for a correct explanation of the data. Still, there are many cases where, unless large interests are involved, a careful and complete survey is practically impossible on account of the expense, and where the chief reliance must be placed on the sanitary analysis. Further, a survey alone, though it may show pollution, does not tell the amount of pollution, nor show the changes that have taken place in the polluting substances. A survey alone can never give all the desired information, and a sanitary analysis, even of a surface water, must always have a value. It is from this point of view that what I have to say regarding surface waters must be considered.

Very early in the study of polluted waters attempts were made to devise methods for detecting certain definite organic compounds which were known to be formed by the decomposition of the nitrogenous products contained in sewage, but without success, and there is very little hope that much knowledge can be gained as to the nature of the organic matter through this line of investigation. The decomposition of the nitrogenous products contained in sewage takes place so rapidly that the isolation of any particular compound like crystin, or any group of compounds, like the amido group, can only be looked for when the pollution is very recent and in very large amounts.

Though it is apparently impossible to isolate from a water any particular nitrogenous organic compound known to occur in sewage, the amount of nitrogen and the amount of carbon contained in these compounds can be determined, and among the first, if not the first, to attempt to determine from the amount of nitrogen and carbon in a water whether the organic matter was of animal or vegetable origin was the late Sir Edward Frankland. On examining the residue left on evaporation of water from peat bogs he found the ratio of nitrogen to the carbon was as 1 to 12, while in the residue from fresh sewage it was as 1 to 2.1, and in the residue from polluted waters, as water containing leakage from cesspools as 1 to 3.1. From these and similar observations he concluded that in surface waters the ratio of the organic nitrogen to the organic carbon in the residue

left on evaporation of such waters afforded trustworthy evidence as to the source of the organic matter. Thus he concluded, that if the ratio was as low as 1 to 3 the organic matter was of animal origin; if as high as 1 to 8 it was chiefly, if not exclusively, of vegetable origin, and that if the ratio was between these two proportions the analyst must be guided in his opinion by the amount of inorganic nitrogen the water contained, and by his knowledge of the surroundings of the source of the water.

This work of Frankland deserves much closer study than it has as yet received. His idea that reliable information regarding the source of the organic matter in a water can be obtained from a knowledge of the amount of organic carbon and organic nitrogen is, in my opinion, undoubtedly sound. The reason why this method has not been more generally adopted is undoubtedly due to the difficulties in correctly determining these two factors by the process used by Frankland, which consisted in measuring the amount of carbon dioxide formed and the amount of nitrogen given off, by the combustion of the residue left on evaporation. If as simple a process for determining the organic carbon as we now have for determining the organic nitrogen could be devised, I believe Frankland's method for deciding upon the character of a surface water would receive the careful study it certainly deserves.

The method of determining the character of a water from the ratio that exists between the carbon and nitrogen, being recognized as of comparatively little practical worth, on account of the difficulty of determining the carbon, attention to-day is concentrated upon the nitrogen content of a water.

The usual method used for determining the nitrogen in the undecomposed nitrogenous compounds is the albuminoid ammonia method of Wanklyn. It gives only an approximation of the total amount of nitrogen thus occurring, but taken in connection with the free ammonia present it undoubtedly often gives valuable indications as to the source of the nitrogenous compounds.

In fresh sewage the amount of nitrogen as free ammonia is from three to four times that of the nitrogen in the albuminoid ammonia, and in sewage effluents from twenty to thirty times, while in peaty water or water containing an infusion of leaves the nitrogen in the albuminoid ammonia is from ten to twenty times the nitrogen in free ammonia, hence when a surface water, not including rain or snow water, gives a greater amount of nitrogen as free ammonia than it does as albuminoid ammonia the indications are that the water has certainly been polluted by sewage and that the source of the organic matter is of animal origin, and with a large amount of nitrogen as albuminoid ammonia (over twenty-five hundredths of a milligram per liter), a ratio of the nitrogen of the free ammonia to the nitrogen of the albuminoid ammonia of less than 1 to 5 is suspicious.

Free ammonia contained in a water may be rapidly removed by plant life or be changed into nitrites and nitrates, and then be absorbed by algal forms, the plant life thus stimulated again adding to the water undecomposed nitrogenous compounds. Consequently, while a low ratio as 1 to 5 between the nitrogen of the free ammonia and the nitrogen of the albuminoid ammonia indicates pollution, the reverse can not be said to be a strong indication that the water is a normal water, one containing only vegetable matter.

It is a well-established fact that it is not safe to form a judgment of a water from the consideration of any single nitrogen factor, and that unpolluted surface waters are known where the nitrogen, as albuminoid ammonia, is much larger than in

certain waters known to be polluted, and the same can also be said of nitrogen as free ammonia and the nitrogen as nitrites and nitrates, and yet something can be learned from the consideration of each of these factors. Nitrogen as albuminoid ammonia in a water analysis, as has been said, represents the nitrogenous matter which has not undergone decomposition, and it is found that in unpolluted waters this amount varies greatly, some waters giving almost no nitrogen in the above form, others as much as one milligram per liter. If, however, the nitrogenous substances are of vegetable origin the water is usually highly colored, and consequently a colorless water, containing that amount of nitrogenous matter represented by 0.25 milligram of nitrogen as albuminoid ammonia per liter is looked upon with suspicion.[1]

Free ammonia always indicates organic matter in the process of decomposition. In unpolluted surface waters it is rarely high, being removed almost as fast as formed by vegetable and animal organisms in the water and an amount of nitrogen as free ammonia above 0.05 milligram per liter is unusual, and if it does occur the water can not be considered as an unpolluted water unless that fact is clearly established by other data.

In drawing conclusions, not only from the nitrogen as free ammonia, but also from the ratio that exists between the nitrogen as free ammonia and the nitrogen as albuminoid ammonia, what is known as the 'seasonal variation' must be considered. Namely, that the amount of nitrogen as free ammonia in northern surface waters is usually greater during the late autumn and early winter than at any other time. This is due to two facts: first, that in cold weather the free ammonia is not absorbed quickly by plant life, and second, that as cold weather begins the surface water of ponds and reservoirs, growing colder, sinks and the bottom water rises, bringing with it the decaying matter from the bottom, increasing the amount of free ammonia often to three times the average amount of the year. This also affects to a certain extent the nitrates, but not nearly to the same amount.

The nitrogen in the other two nitrogen factors of the nitrogen content occurs only in very small amounts. Nitrites in a water are due either to the oxidation of ammonia or to the reduction of nitrates, and being unstable quickly undergo change. Formerly, nitrogen as nitrites in amounts exceeding 0.002 milligram per liter were thought to be a strong indication of recent pollution, and though we now know that unpolluted swamp waters may contain over twice that amount, still more than 0.002 milligram is an unfavorable indication.

Nitrogen in the form of nitrates indi-

[1] It has lately been suggested that the determinations of organic nitrogen should be substituted for the determinations of nitrogen as albuminoid ammonia in water analyses. There is, of course, no question that nitrogen as albuminoid ammonia only gives the amount of nitrogen that is present in nitrogenous substances decomposed by an acid solution of potassium permanganate, and not the total organic nitrogen. With waters, however, unless greatly polluted, the amount thus obtained equals approximately one half of the organic nitrogen, so that the organic nitrogen, if desired, can be calculated sufficiently closely from the nitrogen of the albuminoid ammonia. In sewage work, however, the case is very different. There is no fixed ratio between the organic nitrogen and nitrogen as albuminoid ammonia, and in determining the strength of a sewage, and in determining the amount of purification that takes place in various processes of treatment, the organic nitrogen is a most important factor and should be determined. The nitrogen as albuminoid ammonia, on the other hand, is of little value, changing as the sewage ages, on account of nitrogenous substances not acted upon by an acid solution of potassium permanganate breaking down, giving nitrogen compounds more easily decomposed. The amount of nitrogen as albuminoid ammonia, as a rule, increases as the sewage ages.

cates the amount of nitrogenous matter that has undergone complete decomposition. It is rarely absent from a normal water. It is never present in any large amount, seldom exceeding one tenth of a milligram per liter. Higher amounts than this, being unusual, must be looked upon with suspicion.

The interpretations I have just made apply chiefly to reservoir, pond and lake waters. River waters differ from pond, lake or reservoir waters in the essential particular that the former are in rapid motion and the so-called nitrogen cycle may take place many times during the course of their flow. High nitrogen as free ammonia, as albuminoid ammonia and as nitrites, characteristic of recent pollution in ponds and reservoirs, may, in rivers, be due to the decomposition of the algæ life, which was stimulated by the entrance of sewage in the upper stretches of the river, and the proper deductions to be drawn from these nitrogen data necessitate a knowledge of the river.

Though much valuable information can be obtained, as I have tried to show, from the careful study of the nitrogen content of a water, the water analyst does not depend alone upon these factors in forming an opinion as to the source of the organic matter, and turns to other chemical as well as to bacterial data to substantiate or modify the opinion thus formed. From the chemical point of view the most important of these data is the combined chlorine that a water contains. This is due to the fact that though chloride of sodium occurs in rain water, especially near the sea, and in small amounts is found in all soils, it is a characteristic constituent of sewage, the animal body expelling the same amount of salt as it absorbs.

A careful study of the amount of combined chlorine in normal waters made by Professor Thomas M. Drown, showed that in Massachusetts, where salt-bearing strata do not occur, the amount of chlorine in a surface water depended on its distance from the sea, and that for Massachusetts it was possible to establish normal chlorine, or, as they are commonly called, iso chlor lines.

The work begun by Professor Drown has been carried on by other investigators, and to-day the iso chlor lines for all the New England States and New York and New Jersey have been determined. The result of this work is that the amount of chlorine occurring in the surface waters of the above-named states gives most valuable information. Chlorine above the normal of the region shows pollution. It does not indicate whether the pollution is direct or indirect, but does show that sewage, from which the organic matter and the germs of disease may or may not have been removed by filtration through soil, has had access to the water. Chlorine above the normal is, therefore, always a suspicious sign which must be investigated. I know that it is claimed that in many of the western states, owing to geological conditions, very little information can be obtained from the determination of chlorine. I believe, however, more careful and thorough work is necessary to prove that such is the case, and that further investigation may show that though it is impossible to construct iso chlor lines running through the state, the normal chlorine of different localities in a state can often be determined.

Another factor that is often used in the attempt to decide whether or not a water contains an excessive amount of organic matter is the oxygen consumed. The oxygen consumed is not, however, a measure of the organic matter in a water, but only a measure of the amount of mineral reducing salts plus a certain amount of the organic matter, the amount depending on the method of determination used. It

gives, in my opinion, very little information as to the character of the organic matter, and is only valuable when different surface waters are to be compared with each other, or when used in filtration experiments.

The same may be said as regards color, turbidity and the amount of mineral matter that a surface water contains, that, though of essential importance in deciding on the value of a normal water as a potable water, they give little information as to pollution,

In the early days of bacteriology it was claimed that the final criterion as to pollution of a water would be furnished by aid of that science, and though this hope has not been fulfilled, the information that can be gained by a bacterial analysis is often of the highest importance. It not only aids in the interpretation of the chemical data, but may of itself show, almost without question, that a given water is polluted, for though attempts to isolate special pathogenic germs have generally failed, even in waters known to contain these forms, characteristic sewage forms, like the colon bacillus, can be isolated if they occur in any number in a water. Occurrence of numerous characteristic sewage bacteria can point only to one thing, pollution, and if such forms are found there is no question that the water receives sewage drainage. Bacteriology, however, can not determine, except very roughly, the amount of pollution, or the present condition of the polluting matter, nor does it give but very little, if any, information as to past pollution. If the pollution is recent and of any considerable amount, a careful bacterial examination will show the fact, and probably better and more convincingly than any chemical analysis. If the pollution is more remote, more information can, as a rule, be drawn from chemical than from bacterial data. If the polluting matter has filtered through the soil before entering the water, bacterial work will not indicate the fact.

As a general statement, it may be said that a bacterial analysis, while giving information as regards recent and continuous pollution, gives no information as to the past history of a water, and in this respect differs from a sanitary chemical analysis.

All natural waters contain bacteria, and even if the true colon bacillus does not occur in many normal surface waters, one closely akin to it can often be found if a sufficient amount of the water be taken for examination. The mere presence of bacteria or even the colon bacillus, if found only in large volumes, does not, therefore, signify pollution.

The number of bacteria found in a surface water depends not only upon the organic matter a water contains, but to a greater or less extent upon various natural causes, such, for instance, as the character of the soil of the watershed, the rainfall, the time of year the examination is made, and these considerations must be taken into account when attempting to determine the character of the water from the number of bacteria present. Arbitrary standards have been proposed from time to time, and of these Dr. Sternberg's, that a water containing 500 bacteria to the cubic centimeter is open to suspicion and one containing over 1,000 bacteria is presumably contaminated by sewage or surface drainage, is probably as satisfactory as any that could be devised. Though most artificially filtered waters and many reservoir waters contain not over 100 bacteria to a cubic centimeter, to state that a surface water showing on a single examination a much greater number than 500 per cubic centimeter was probably polluted, would be unjustifiable, and the significance of the data can only be determined when the average bacterial count of the water under examination is known, or when it is con-

sidered in connection with the chemical data.

A certain added amount of information may be gained as to the weight to be placed on the total bacterial content of a water, by also determining the number of colonies that develop on agar plates at blood temperature and the number that decompose lactose with the formation of acid. According to Rideal and also to Winslow, in an unpolluted water the proportion between the total number of colonies obtained on gelatine plates at 70° Fahrenheit and the number obtained on agar plates at 98 degrees Fahrenheit should not be greater than 12 to 1, and Winslow and Prescott state that in normal Massachusetts waters the total number of organisms growing at the body temperature rarely exceeds 50 per cubic centimeter, and that acid producers are generally absent.

The information that can be obtained by the examination of a water for the colon bacillus is much more positive and important than that which can be obtained from a bacterial count, for though undoubtedly the colon bacillus is not confined to the secretions from mammals, the intestines of the higher vertebrates form a better environment for its growth and multiplication than any other which occurs in nature, consequently drainage from domestic and agricultural wastes of human life must be considered as the method by which large numbers gain access to surface waters. It follows, therefore, that a water containing large numbers of colon bacilli must be looked upon as a polluted water, and the generally accepted statement of to-day is that if the colon bacilli occur in sufficient numbers in a surface water to be detected in the majority of one cubic centimeter samples tested (at least six samples being taken), it is almost positive indication of recent sewage pollution. Failure to detect colon bacilli when water is thus tested is not, however, a proof that the water is a normal water, though it is usually a proof that the pollution, if it exists, is not recent nor continuous.

Having attempted to give what I believe can be learned from the sanitary analysis of a surface water, ground and artesian waters remain to be considered, and with these waters the analyses assume far greater importance than with surface waters, for the area of the source of the water is often indefinite and rarely determinable with accuracy, and a careful and complete survey of what may be called the watershed is very difficult and generally impossible.

In determining the character of a ground water we make use of the same data that we have considered in speaking of surface waters, but the deductions drawn from the data are very different. This is due to the fact that the two waters differ so greatly in their chemical and biological characteristics that they can not be judged by the same standards.

Ground waters are surface waters which have percolated through the soil, and the changes which they have thus undergone are very similar to the changes which take place in the process known as slow sand filtration and it is from a study of this process that we are able to follow the changes that take place when surface waters pass into the soil.

In slow sand filtration of water we find that odor, color and turbidity are removed, that about 90 per cent. of the nitrogenous organic matter is oxidized, and that a part, varying from 50 to 75 per cent. of the nitrogen of the organic matter, is found in the filtrate as nitrates, that the amount of chlorine remains unchanged and that the bacteria are to a very large extent removed.

To apply the information thus obtained to ground waters it can be stated that an unpolluted ground water should be free

from color, odor and turbidity, that the amount of nitrogen as free and albuminoid ammonia should be very much less than in an unpolluted surface water, that the amount of nitrogen as nitrates should not exceed by more than 50 to 75 per cent. the nitrogen of nitrates of normal waters, and that the amount of chlorine should be the chlorine of the region, and bacterially the water should be very pure.

To go further, and from the filtration experiments and from the study that has been made during the past twenty years on ground waters, and express the statements of the last sentence in concrete numbers, it might be said that the best ground waters should certainly contain not over 0.01 milligram of nitrogen as free ammonia or over 0.02 milligram of nitrogen as albuminoid ammonia, no nitrogen as nitrites, not over 0.1 milligram of nitrogen as nitrates in a liter of water, and chlorine not above the normal of the region. When a water contains more than 0.05 milligram of nitrogen as free ammonia and 0.08 milligram of nitrogen as albuminoid ammonia, or 0.12 milligram of nitrogen as albuminoid ammonia, even if the free ammonia occurs in very small amounts, it is a sign of imperfect filtration or of subsequent pollution, and consequently such water should not be used for household purposes.

In making this statement, the fact that the nitrogen of organic matter in a soil can be oxidized by ferric oxide to ammonia has not been lost sight of. This is, however, not of common occurrence, and unless it can be proved in a given case to have taken place, the deductions that have been made must be considered as correct.

Nitrites in a ground water are a most unfavorable indication, though they are sometimes found in unpolluted well waters, due to the reduction of nitrates by iron, sand, or iron pipes through which the water is drawn from the well.

A ground water containing an amount of chlorine much in excess of the normal of the region and nitrogen as nitrates approaching 3 milligrams per liter, even with very small amounts of nitrogen as free and albuminoid ammonia, must be considered to have been originally polluted surface water, and on this account not a water free from possible danger.

Though, as has been stated, the number of bacteria in a ground water should be small, not over one hundred per cubic centimeter, numerous investigations of well waters giving no indication of pollution have shown that this number is often largely exceeded. This may be and is often due to the falling into a well of air and soil bacteria. The number of bacteria in well water, if not reaching into the thousands, can not, therefore, of itself be considered as an indication of pollution, though the cause of excessive numbers requires explanation.

A much better indication as to the pollution of ground waters is the ratio that exists between the number of bacteria developing at the temperature of 70° Fahrenheit and the number developing at blood heat, and the same conclusions as with surface water may be drawn from the ratio that is thus found.

The occurrence of acid forming bacteria indicates pollution, and the presence of colon bacillus in a ground water is almost positive proof that sewage drainage is present.

Artesian or underground waters are ground waters which have passed into or through underlying rock strata. The sanitary value of the analyses of such waters should be very great, for the pollution, if polluted, may be due not only to carelessness, which allows direct and continuous contamination from above, at the point where the water is tapped, but often to ground water which has not been purified

by filtration through soil having direct connection with the water in the well, owing to the seamy or faulty character of the rock or to the percolating water wearing channels through the rock, as often occurs in limestone formations. The source of pollution may, therefore, be many miles from the well, and through careful study of the geological formation, the dip of strata and general characteristics of the neighborhood should be made, the main reliance for deciding whether or not the water is a polluted one must often be the data obtained from the chemical and bacterial analyses.

Unfortunately, however, in the study of artesian water perplexing chemical and bacteriological results are often obtained. In artesian waters so situated that surface pollution seems impossible, amounts of nitrogen as free ammonia, as nitrites and as nitrates have often been found which, if occurring in ground waters, would cause them to be considered as polluted. The nitrogen of the nitrates in these waters may be due to fossil remains, and the nitrogen as nitrites and as free ammonia to the reduction of the nitrates by chemical action, as contact with iron sulphide, and the occurrence of the nitrogen as free ammonia also sometimes to some salt of ammonia existing in the strata through which the ground water passes. On this account the determination of the nitrogen content does not give as satisfactory data from which to draw conclusions as those obtained from the analysis of ground water.

The interpretations of the data obtained, however, always bearing the above facts in mind, are nearly the same as those stated when considering ground waters. An unpolluted artesian water should not contain any nitrogenous or carbonaceous organic matter and consequently the nitrogen as albuminoid ammonia should not be over 0.02 milligram per liter and the oxygen consumed, nitrites and mineral reducing substances being absent, should not exceed one tenth of a milligram.

The chlorine factor is of much less importance in the study of artesian waters than in the other two classes, for, as a rule, we have little or no knowledge of the normal chlorine of deep waters of any given region and consequently this datum has only the same value that it has in the analysis of surface waters in localities where the normal chlorine has not been determined.

Bacterially an artesian water should be a very pure water and at one time it was considered that an unpolluted artesian water was a sterile water. To-day, however, this is not the case. Examination of wells has shown that while in a few cases the water may be sterile, in the majority bacteria are present in varying numbers. These are, however, generally of slow-growing types and are not indicative of pollution. Should an artesian water, not in a region of thermal springs, show bacteria which develop in considerable numbers at the body temperature, the interpretation would be the same as in a ground water, that unpurified water or sewage was entering the well either from the immediate environment or through fissures and crevices in the lower strata. Acid-forming bacteria and the colon bacillus should never be found in artesian waters.

I am afraid I have already occupied by far too much of your time in giving my opinion as to the sanitary value of a water analysis and the information that can be derived from such an analysis, and in conclusion would only reiterate that to form a judgment as to the wholesomeness of a water the data of a sanitary water analysis, the source of the water, whether surface, ground or artesian, must be known; that a survey, even of a surface water, though

it may show whether or not the water is polluted, does not give information regarding the amount or condition of the polluting matter; that with ground and artesian waters it often gives very little information, and that an opinion regarding the character of such waters must, as a rule, depend on the sanitary analysis.

LEONARD P. KINNICUTT.
WORCESTER POLYTECHNIC INSTITUTE.

SCIENTIFIC BOOKS.

Handbook of Metallurgy. (In two volumes.) By Dr. CARL SCHNABEL, Professor of Metallurgy at Berlin. Second edition. Volume I., Copper, Lead, Silver, Gold. Translated by HENRY LOUIS, Professor of Mining at Armstrong College, Newcastle-on-Tyne, England. 8vo, cloth covers, 715 illustrations. Pp. 1,123. Contains a geographical and a general index. New York and London, The Macmillan Company. Price, $6.50.

This volume, which is the English translation by Professor Louis of Dr. Schnabel's classic work, needs but the mention to declare its excellent merit, so widely known are both author and translator. The first German edition of Dr. Schnabel's admirable work of two volumes appeared in 1898, and was shortly afterward translated into English by Professor Louis. Both works were so well received that Dr. Schnabel issued a second edition, Vol. I. in 1902 and Vol. II. in 1904. The present book under review is Professor Louis' English translation of Vol. I. The English translation of Vol. II., which will also be made by Professor Louis, is expected to be published in 1906.

The translation of Dr. Schnabel's great work furnished the first complete treatise on metallurgy (except for iron) that has appeared in the English language, although many small text-books, covering the entire field but making no claim to thoroughness of detail, have been published; as have also several excellent monographs dedicated to the metallurgy of individual metals.

Dr. Schnabel's object has been to give a complete description of the metallurgical treatment of all the metals (except iron), pointing out the underlying chemical principles, and for each case, giving examples drawn from actual practise. His broad knowledge of the subject has rendered him eminently fitted for this herculean task, and he has supplemented his personal knowledge by full reference to and abstract from the works of that well-known trio of American metallurgical writers—Egleston, Peters and Hofman. So excellent was his work that the first edition received well-merited praise throughout the metallurgical world. A few adverse criticisms were made, but these were directed mainly to the mechanical features of the books—for instance, a collective index for both volumes was given at the end of volume II. and no index whatever in volume I. This objectionable feature of the first edition has been removed in the second edition, each volume of the latter having its individual indexes—an improvement of great value in referring to the books.

Another criticism of Dr. Schnabel's work was that too much space had been given to the history of active processes and the description of obsolete ones; but knowledge can not be too thorough for the earnest student or inventor who needs a reference work that will cover the entire subject. A knowledge of both past and present practise is needed in order to know not only 'what to do' but also 'what not to do.' The chemical principles which underlie a metallurgical process remain fixed and constant, but the application of new forces, the development of mechanical appliances for handling raw materials and part or wholly finished products (indeed, in many cases, for the physical action of the furnace itself) are important factors bearing on the proper conduct of metallurgical treatment of ore or metal. Frequently, metallurgical processes are of such rapid development that theory to-day becomes practise to-morrow; and, as a corollary to this fact, good practise to-day becomes merely historical record to-morrow. For this reason a comprehensive treatise on the subject should contain not only a description of present practise, but also a record of the developments which have led to it. In

this respect, Dr. Schnabel has attained success.

The second edition has been largely rewritten, as may be appreciated by the increase of pages, from 873 to 1,123, and of illustrations, from 569 to 715. As a whole, the book is reliable and should be in the hands of all students of metallurgy or metallurgical chemistry and all earnest workers in the practise of the art. The material is sufficiently comprehensive to give a thorough review of present metallurgical practises and the history of their development from early times.

JOSEPH STRUTHERS.

NEW YORK,
December 23, 1905.

SOME RECENT BOOKS RELATING TO ANALYTICAL CHEMISTRY.

A Text-book of Chemical Arithmetic. By H. L. WELLS, M.A., Professor of Analytical Chemistry and Metallurgy in the Sheffield Scientific School of Yale University. New York, John Wiley & Sons. Pp. vii + 169. 12mo. $1.25.

A Manual of Qualitative Chemical Analysis. By J. F. MCGREGORY, Professor of Chemistry and Mineralogy in Colgate University. Boston, Ginn & Co. Pp. xiv + 133. $1.00.

Techno-Chemical Analysis. By Dr. G. LUNGE, Professor at the 'Eidgenossische Polytechnische Schule' at Zurich. Authorized translation by ALFRED I. COHN, author of 'Indicators and Test Papers,' etc. New York, John Wiley & Sons. Pp. vii + 135. 12mo. $1.00.

Wells's Chemical Arithmetic.—The subject is treated under three general heads: 'Calculations Relating to Weights,' 'Calculations Relating to Gases' and 'Calculations Relating to Volumetric Analysis.' These chapters are divided into sections according to the special character of the problems, and the solution of each kind of problem is illustrated by examples. In addition, a number of problems to be solved are added, the answers to which are placed in the back part of the book. One of the most important features is the first chapter on approximate numbers. Those who have watched the average student carry out the calculations to eight or ten decimals when the result is defined to one or two decimals will appreciate this excellent presentation of the subject. Indeed, all through the book this matter is kept before the student and in many cases the last significant figure of a result is underscored to call attention to its being affected with uncertainty. There are also to be found in this chapter several pages on abbreviated multiplication and division and on the use of logarithms.

The book is designed for students of quantitative analysis and contains little that does not bear directly on analytical calculations. Arithmetical methods are used almost entirely. This the experience of the reviewer is against, as he has always found algebraic methods clearer and more concise. There is no section devoted to calculations involving the density of solutions, which must be looked upon as a serious omission in a work of this sort.

An appendix contains a small list of the usual tables and a table of five-place logarithms.

McGregory's Qualitative Analysis.—In the preface the author states that his aim is to strike between the larger works of the Fresenius type and the abbreviated texts. This would seem to be the aim of most authors of recent treatises on qualitative analysis, for the book at once impresses one as being of the same general size and shape as half a dozen others.

The treatment of the subject is also the conventional one as opposed to some of the later works that embody physical-chemical facts and speculations in explanation of the reactions involved. In arrangement, however, some special features are to be seen. For instance, the usual characteristic reactions are given for all the metals and non-metals before any analysis proper is reached. The usual schematic tables for the systematic examination are omitted, the author considering this better pedagogically.

For those who may prefer this peculiar arrangement the book is to be recommended.

Lunge's Technical Analysis.—A wide range of subjects is presented by this little book, there being chapters on technical gas analysis, fuels and heating and on inorganic chemical

manufacturing. It goes without saying that in so small a compass these subjects can not be treated in detail. The book aims to answer the question as to what determinations are usually made in the examination of technical materials. To the average student it would be of little value, owing to the briefness of its descriptions, but the chemist of some training will find it excellent in pointing the way to the proper procedures in technical analysis.

CHARLES WILLIAM FOULK.

A Handbook of the Trees of California. By ALICE EASTWOOD, Curator of the Department of Botany, California Academy of Sciences. San Francisco. 1905. (Occasional Papers of the California Academy of Sciences, IX.) Pp. 80. Plates 52.

This is a popular manual of the native trees of California. The author's style is simple and clear. There is no waste of words and the descriptions of the species are in plain English, omitting as far as possible the use of latinized words so highly favored by some systematists. An interesting and most useful departure is the introduction of two artificial keys, one based upon leaf forms, the other on fruit forms. However, the prime excellence of the work depends upon the illustrations. Some of the illustrations are from the drawings of Dr. A. Kellogg, one of the founders of the California Academy of Sciences. The half-tone work is excellent. The trees of Washington and Oregon are included, as it was found that there were only a few not represented in California.

The trees of California are world-known and botanists everywhere will welcome this work.

ALBERT SCHNEIDER.

SOCIETIES AND ACADEMIES.

THE BIOLOGICAL SOCIETY OF WASHINGTON.

THE 406th regular meeting of the Biological Society was held in the Assembly Hall of the Cosmos Club, November 25, 1905, with President Knowlton in the chair and 69 persons present.

The first paper of the evening was by Dr. L. O. Howard, presenting 'More Notes on the Yellow Fever Mosquito.' He said that the next morning after presenting the former communication on the same subject before the society, he left Washington for New Orleans and Texas. At that time (October 28) the Texas quarantine against New Orleans had not been relieved, so that he was obliged to go to Texas first by way of St. Louis. He returned to New Orleans from Texas on November 6 and spent some days in the city studying the conditions that prevailed at that time and talking with the men who had charge of the victorious fight against the yellow fever, then just concluded. He gave a number of observations made by Doctor White, Doctor Richardson, Doctor Blue and other surgeons in the Public Health and Marine-Hospital Service who had been stationed in New Orleans during the summer, relative to the out-of-the-way breeding places in which the yellow fever mosquito had been found, and spoke especially of the new culicide discovered during the summer and which seems to be especially effective against mosquitoes, without having the deleterious properties of sulphur dioxid. Lantern slides were exhibited showing New Orleans breeding places, methods of fumigating houses, and the general characteristics of the portions of the city in which the epidemic had been severest. He also showed a few slides illustrating sanitary conditions at Panama.

In discussion of this paper, Dr. C. W. Stiles said that it is most interesting that our knowledge of the disease includes the facts of its transmission, but of its cause. The disease is handled by methods of prevention. The period of infection necessary to inoculation is known. The female mosquito must transmit the disease to man. In comparison, the best known ticks transmit disease to their progeny, then through them to the human patient. A recent German paper makes the assertion that malaria is transmissible to the offspring of the mosquito. A Paris paper makes the same statement of *Stegomyia*. This is doubted in this country. There are numerous men working on the identity of the yellow fever parasite. Many known Arthropoda are necessary for the transmission of certain diseases. Cholera may be transmitted by flies.

Malaria must be carried by mosquitoes. The Crustacea which carry disease are parasitic. It looks as if an animal parasite were necessary for the transmission of yellow fever. The course of the disease in man is rapid. In the mosquito it is slow. Rapid reproduction is characteristic of a non-sexual method; slow reproduction of a sexual method. It is probable that there is an alternation of generations in the mosquito and man. Characteristic Protozoa which carry disease may be Rhizopoda, Flagellata or Sporozoa. It is probable that the yellow fever parasite belongs to one of these classes.

The second paper was a report of 'The New York Meeting of the American Ornithologists' Union,' by Dr. T. S. Palmer. This meeting has been reported in full elsewhere.

The third paper was by Mr. W. W. Cooke, on 'Discontinuous Breeding Ranges of Birds.' The speaker showed many lantern slides illustrating the facts of summer range, winter range, breeding range, and how in some cases these coincide, in others these overlap, and in still others these are quite separate seasonally, and again even geographically, sometimes by distances almost hemispherical.

E. L. MORRIS,
Recording Secretary.

THE TORREY BOTANICAL CLUB.

THE club met at the New York Botanical Garden, October 25, 1905, with Professor Underwood in the chair and eighteen persons present.

The announced program consisted of 'Further remarks on the vegetation of the Bahamas,' by Drs. N. L. Britton and C. E. Millspaugh.

Dr. Millspaugh in opening the discussion remarked that the flora of the Bahamas is so locally distributed that all the islands must be visited before a complete enumeration can be attempted, and that a thorough exploration of the archipelago at an early date is very desirable. He then reviewed the history of the exploration of the Bahamas, mentioning the work of Brace, Britton, Catesby, Coker, Cooper, Eggers, Hitchcock, Howe, Madiana, Millspaugh, Nash, Mrs. Northrop and Swainson (?); and summarizing the work done upon each island.

It is pretty certain that the islands have all been submerged at a very recent geological period, so that the question as to whether they were ever previously connected with the mainland has no significance for the present plant population. The flora seems to have more in common with Cuba and Hayti than with any other region.

Dr. Britton then described some of the noteworthy features of the flora, exhibiting specimens of several of the recently discovered endemic species, and of the palms.

Dr. Howe discussed some of the marine algæ of the Bahamas, remarking upon the apparently very local distribution of some of the species. He exhibited specimens of a new *Halimeda,* and of a new genus, *Cladocephalus,* soon to be described by him in the *Bulletin.*

Dr. Barnhart remarked that he had recently found some evidence about one Swainson, who is supposed to have collected plants in the Bahamas between 1830 and 1842. Some doubts had been expressed as to whether this could have been William Swainson, the zoologist, who is not known to have been in that part of the world at the time indicated, but the evidence goes to show that the specimens in question had been collected for Swainson by some unknown correspondent, and by him communicated to the herbarium at Kew, where they are now found.

Dr. MacDougal exhibited a mounted series of leaves of two hybrid oaks, *Quercus Rudkini* Britton (supposed to be a hybrid between *Q. marylandica* and *Q. Phellos*), the original specimens of which were recently found to be still growing near Cliffwood, N. J.; and *Q. heterophylla* Bartr. (supposed to be a hybrid between *Q. Phellos* and *Q. rubra*) from Staten Island. The specimens exhibited showed an interesting range of variation, and acorns of both hybrids have been planted, so that they can be studied hereafter in the light of recent theories of evolution.

ROLAND M. HARPER,
Secretary pro tem.

THE CALIFORNIA BRANCH OF THE AMERICAN FOLK-LORE SOCIETY.

The fourth meeting of the California Branch of the American Folk-Lore Society was held in Room 22, South Hall, University of California, Berkeley, Tuesday, November 14, 1905, at 8 P.M. Mr. Charles Keeler presided.

The minutes of the last meeting were read and approved. The following persons approved by the council were elected to membership in the society, the secretary being instructed to cast the vote of the society for them: Mr. R. F. Herrick, Mrs. S. C. Bigelow, San Francisco; Mrs. Zelia Nuttall, Mexico; and Mr. and Mrs. Oscar Maurer, Berkeley.

The president spoke briefly on the aims of the society, reviewed its history, and announced coming meetings.

Professor John Fryer then delivered a lecture, illustrated with specially prepared lantern slides, on 'Fox Myths in Chinese Folk-Lore.' Professor Fryer briefly discussed Chinese folk-lore in general, its hold on the mind of the people, the important place occupied by superstitions regarding the fox, and recounted a number of interesting and suggestive fox tales.

Two hundred persons attended the meeting.

The fifth meeting of the California Branch of the American Folk-Lore Society was held in the Unitarian Church, Berkeley, Thursday, December 7, 1905, at 8 P.M. Professor John Fryer presided.

The minutes of the last meeting were read and approved.

The following persons approved by the council were elected to membership in the society, the secretary being instructed to cast the vote of the society for them: Mrs. M. S. Biven, Oakland, Miss G. E. Barnard, Oakland.

Professor Wm. F. Bade delivered a lecture on 'Hebrew Folk-Lore,' based primarily on folk-lore elements in the Book of Genesis.

At the conclusion of the lecture a vote of thanks was tendered Professor Bade, as also the trustees of the Unitarian Church.

One hundred and fifty persons attended the meeting.

A. L. Kroeber,
Secretary.

DISCUSSION AND CORRESPONDENCE.

THE SOILS FOR APPLES.

In connection with the instructive article of H. J. Wilder on soils suitable for the production of apples (Science, December 1), I call attention to one point which is only casually mentioned by him.

I think that in general we may draw very useful conclusions as to the primary needs of culture plants from the habitats of their wild congeners or progenitors. In the case of the apple, we have the wild crab apple as a precedent; and any one who has paid attention to such matters will remember the groves of fragrant crab apples on the black prairies of the middle west and southwest, where they sometimes form the almost exclusive tree growth, though varied occasionally with clumps of the large-fruited red-haw (*C. coccinea*) and a honey locust here and there. The soils of these prairies are all distinctly and sometimes strongly calcareous; and where the latter is the case we usually find the highest color both of blossoms and of fruit of the crab, and also the most abundant crop. The tree at times invades adjacent hills, and here we may see, by way of contrast, pale flowers and fruit, on long branches with a sparse crop.

The wild apple is distinctly a calciphile plant, frequenting the heaviest as well as light sandy soils, provided sufficient lime carbonate be present. The latter condition rarely exists in the humid region in very sandy soils, because from these the lime is quickly leached into the subsoil or subdrainage whenever they are cultivated. Hence naturally the failure of apple orchards to maintain themselves on sandy soils for any length of time, as indicated by Wilder. For it is *a priori* reasonable to suppose that the cultivated apple, while *tolerating* soils poor in lime, will also prefer the calcareous soils on which its ancestors flourished, sometimes to the exclusion of all other tree growth.

The fact that a reasonably calcareous soil is one of the prime conditions for profitable apple culture will, I think, be found abundantly verified in the apple-producing districts of the United States. But it must be understood distinctly that the current definition of

a calcareous soil, viz., one that will 'effervesce with acids' (requiring the presence of at least three per cent. of carbonate), goes far beyond what insures the presence of calciphile plants in thousands of cases. I have elsewhere summed up what may be said on this point, to the effect that while in heavy clay lands as much as six tenths per cent. of lime in the soil may be necessary to secure the advantages of calcareous lands, in the case of light sandy soils one tenth per cent. may be sufficient to produce natural calciphile growth, and, therefore, also the cultures which, like the legumes, demand soils which are not only neutral, but which shall be able to supply to them freely the lime which forms so prominent an ash ingredient.

In this, the proper sense of the word, calcareous soils will be found to exist not only in limestone districts, but in all derived from hornblendic rocks, including black lavas and basalts, and also from the rocks containing either labradorite or some of the soda-lime feldspars. Such soils rarely effervesce, but when wetted they show with red litmus paper, at the end of twenty minutes, the blue reaction which is wholly independent of 'alkali.' Even dilute acetic acid will in that case readily dissolve from the soil enough lime to give a plain reaction with oxalates.

I trust that this point of view may be made the subject of verification by Mr. Wilder as well as others. E. W. HILGARD.

BERKELEY, CAL.,
December 8, 1905.

ISOLATION AS ONE OF THE FACTORS IN EVOLUTION.

IT was with much pleasure that I read the article of President D. S. Jordan on 'Isolation' in a recent number of SCIENCE,[1] and, aside from the fact that I am able to add a large number of cases, I have nothing to comment upon. But the subsequent article by Professor J. A. Allen[2] demonstrates again that the principle of isolation or separation is not generally understood in its full meaning.

Jordan expresses the opinion that isolation is a factor in the formation of every species on the face of the earth. I can not strongly enough endorse this view, for it is absolutely unthinkable that two species may be derived from one ancestral species without the action of isolation. All the instances introduced by Allen as opposed to this view are rather in support of it. He concludes that in variations of certain widely distributed species, which pass into each other from one extremity of the range to the other, no isolation by barriers exists, but that there is continuous distribution. Indeed, there is continuous *distribution*, but there is no continuity of *bionomic conditions*. These different bionomic conditions pass into each other, and, consequently, we have varieties, and not species. This is clearly the first step toward complete isolation, and for complete isolation 'barriers' in most cases are not absolutely necessary features.

It is not quite correct to conceive isolation only in its coarsest sense, as topographic or climatic separation. This mistake is often made, but I pointed out, about ten years ago, that the real and most important value of the principle of separation lies in its general *bionomic* sense. The same idea was maintained long ago by Gulick, and has been treated recently by him in an elaborate monograph.[3] I am fully in accord with most of Gulick's ideas as to the influence of separation upon the formation of species, chiefly as opposed to the senseless abuse of the term species introduced by the de Vries school. 'Bionomic separation,' as used by myself, and 'habitudinal segregation,' as used by Gulick, are practically identical terms.

With Jordan (and with Gulick) I believe that 'bionomic separation' is absolutely necessary for the formation of species, but that it is not the only factor taking part in the process called 'evolution.' With regard to this, I may be permitted to quote from a paper published by myself in 1896,[4] which seems to have been overlooked generally:

> * * * We have to distinguish *four factors* accomplishing the diversity, development and differentiation into species of organic beings: we

[1] SCIENCE, November 3, 1905, p. 545 ff.

[2] SCIENCE, November 24, 1905, p. 661 ff.

[3] Gulick, J. T., 'Evolution, Racial and Habitudinal,' Carnegie Institution, Washington, 1905.

[4] 'On Natural Selection and Separation,' *Pr. Amer. Philos. Soc.*, 35, 1896, pp. 175–197, especially pp. 188–190.

may call conveniently this whole process: *origin of species.*

I then proceed to characterize these four factors, which are the following: (1) variation; (2) inheritance of variations, 'consanguinity becomes morphologically visible'; (3) natural selection, acting upon the material produced by variation and inheritance, improving the average, and causing, under certain circumstances, 'mutation';[5] (4) 'bionomic separation' (p. 190, *l. c.*), forming what we call 'species.'

> The four factors named, *variation, inheritance, selection* and *separation*, must work together in order to obtain different species; * * * it is impossible to think that one of them should work by itself, or that one could be left aside.

I have further demonstrated in the paper referred to, that Darwin already held practically the identical opinion, although he did not properly recognize 'bionomic separation,' and introduced, in its place, the 'principle of divergence.' In the face of this fact, it is only to be regretted that bionomic separation or habitudinal segregation has not received due attention, and is generally not understood in its true meaning by those that have little experience in field work; indeed, it is impossible to get an appropriate idea of it in the museum or the laboratory, and also the botanical garden is entirely unfit to bring home its significance. I hope, however, that its real value and real meaning will become more generally known by and by. For those that have no chance to convince themselves in nature of the ever-presence of bionomic separation, the study of Gulick's book will be advantageous.

E. A. Ortmann.

Pittsburg, Pa.

SPECIAL ARTICLES.

REACTIONS IN SOLUTIONS AS A SOURCE OF E.M.F.

Permit me to call to the attention of the readers of this journal certain observations which I have recently made relative to the chemical reactions in solution as a source of the electric current. So far as I am informed the phenomenon described below has not previously been recorded.

Some time ago, while carrying on a series of experiments upon photo-electric effects, certain features of the investigation led me to suspect that *any* and *all chemical reactions* give rise to a *measurable* quantity of electrical energy.

In order to test this I introduced into a very small glass vessel two platinum wires, No. 26, to serve as electrodes. These electrodes were as nearly identical in dimensions as it was possible to make them. They extended down into the cell about two centimeters, at a distance apart of, perhaps, two millimeters. The cell thus constructed held approximately 3 c.c. The electrodes were then connected by means of a short wire to a sensitive galvanometer.

About 2 c.c. of silver nitrate solution (5:25) were introduced into the cell. Two or three drops of concentrated HCl were then added to the silver solution in the cell. Immediately when the acid came in contact with the salt a decided deflection was manifest on the instrument. Stirring the reacting bodies increased the deflection and at times reversed the direction of the current. The maximum deflection was about twenty-five scale divisions.

At first the acid was introduced *between* the platinum electrodes. Later it was found that if the reagent was allowed to come in contact with the silver solution *about* either *one* of the electrodes the direction of the resulting current, as indicated by the galvanometer, could be predicted, *i. e.*, the current *in all cases* left the cell by that electrode about which the reaction was taking place *least* vigorously.

Different concentrations of the salt and acid were tried. It was found that the deflection of the needle was roughly proportional to the concentration of the reacting bodies. It was also observed that the current ceased when the reaction was complete, which, when the solution was not stirred, took at times a minute or more.

Other combinations were tried as follows: NaCl and H_2SO_4; BaCl and H_2SO_4; $CuSO_4$ and NH_4OH; KOH and HCl. Each of the above reactions gave rise to a decided deflection of the needle, the current continuing

[5] Not the 'mutation' of de Vries, which term is decidedly ill chosen, being preoccupied long ago by Waagen, Neumayr and W. B. Scott, and used in an entirely different sense.

until the reaction was completed. The most decided deflection of the instrument occurred in those cases where the reagent was permitted to act more vigorously about *one* electrode than the other.

To test as to the possibility of the phenomenon being due to a difference in concentration at the electrodes, the cell was nearly filled with water and a saturated solution of NaCl was introduced into the water about *one* of the electrodes. While a very slight deflection of the needle was manifest, it was not in any case comparable with the result mentioned above, being not greater than one scale division.

Another possibility is, of course, a thermal effect. To test this the cell was again filled with water and concentrated H_2SO_4 was introduced about *one* of the electrodes. A slight deflection was noted—in magnitude about the same as in the last-mentioned case, one scale division.

In addition to the above evidence against a possible thermo effect might be mentioned the fact that the magnitude of the current did not appear to be a function of the heat of reaction.

The above would seem to indicate that the current is not due to a difference in concentrations at the electrodes or to a thermo-effect. However, the data at present at hand would scarcely justify a definite conclusion in this respect.

As to the ultimate cause of the current observed I am not at the present writing prepared to venture an opinion. I make this communication in order that other investigators may test the matter for themselves.

Chas. A. Culver.
Randal Morgan Laboratory of Physics,
University of Pennsylvania,
October 18, 1905.

PEAR-LEAF BLISTER-MITE (ERIOPHYES PIRI NAL.).

As with many of our orchard pests, this is an introduced species, and was undoubtedly brought into the United States in importations of nursery stock. Since its introduction it has, largely through the nursery trade, been widely distributed in the pear-growing sections, where it is usually a familiar pest of this kind of fruit. Within the past few years added interest has been shown towards this species in this state because of its attacks upon apple foliage. In 1902 the attention of this station was directed to its work in two widely separated orchards, but during the past two years it has been very conspicuous in many orchards in various parts of the state where it promises to be an important pest of this fruit.

In the study of the habits and distribution of *Eriophyes piri* in the state of New York, two other European species have been found upon pear and apple leaves. These have been recorded by Dr. Nalepa by the names of *Epitrimerus piri* and *Phyllocoptes schlechtendali.* The latter are distinguished from *Eriophyes piri* in that the abdominal rings on venter are nearly twice as many as on dorsum. *Epitrimerus piri* differs from *P. schlechtendali* by having two longitudinal furrows on dorsum of abdomen. The former is found upon apple and pear leaves, while the latter has so far been detected only on apple foliage.

P. J. Parrott.
N. Y. Agricultural Experiment Station,
Geneva, N. Y.

QUOTATIONS.

THE METRIC SYSTEM.

The American people have a world-wide reputation for their ingenuity in devices to save time and labor. It is an anomaly that such a progressive people has failed to see the enormous loss of time and labor incurred in the retention of medieval and confusing weights and measures.

Three fourths of the enormous foreign trade of the United States last year was with countries having the metric system—the system now in use among four hundred and fifty millions of people. Merchants import liquids by the liter, textiles by the meter, foods and drugs by the kilogram, and the innumerable consignments must be calculated into and sold by different measures of volume and of length and by avoirdupois weight and troy weight and apothecaries' weight. In exporting commodities, on the other hand, quantities, weights and measures must be laboriously converted

into the terms of the metric countries to which they are shipped.

One may imagine the time and labor lost in these processes and the tendency to prevent expansion of our commerce that these vexations must exert, for where other things are equal the four hundred and fifty millions of metric potential customers naturally incline to deal with those who speak the same trade language as themselves. The views of exporters and importers recently presented through the *Herald* show how keenly they feel this handicap and how eager they are for the adoption of the simple, uniform and widely used system which would clear the existing obstructions from the pathway of commerce.

If we had no commercial relations whatever with foreign countries it would seem incongruous that the American people, while progressing in all other directions, should have failed to adopt such a unified and simple system as the metric for the facilitation of internal trade—and this is nearly twenty times as large as that done with other countries. The first step toward adopting the metric system was taken forty years ago, when Congress passed the law legalizing it in contracts and court pleadings. Six years after that step was taken Germany adopted the metric system—and it has contributed not a little to the industrial and commercial growth at which the world marvels—while we are still weighing copper by one 'standard,' silver by another and drugs by a third, with other confusions 'too numerous to mention' in measures of volume and length.

We have been outstripped in the adoption of the metric system by Japan and by countries that the average American condescendingly regards as half civilized. The metric is taught in our schools, but the children must also learn the complicated systems that are retained in use, although a full year's time would be saved in their education if these were dropped. In electrical operations, in engineering, in pharmacy, in industries that demand nice measurements, like the manufacture of automobiles, and watchmaking, and in numerous other fields the metric system is in common use to-day. Why longer continue the confusion and the loss of time and labor and accuracy involved in retaining the obsolete weights and measures? Congress should awaken to the fact that this is the twentieth century and comply with the demand for adoption of the metric system.

CURRENT NOTES ON METEOROLOGY.

METEOROLOGY AT THE EIGHTH INTERNATIONAL GEOGRAPHIC CONGRESS.

The Eighth International Geographic Congress was held in the United States in September, 1904, and the *Report* has just been published, 'by courtesy of the United States Congress at the Government Printing Office.' The number of papers devoted to meteorological and climatological subjects was not large, but the matters treated in these papers were of some general interest. Dr. Cleveland Abbe, Jr., in his 'Meteorological Summary for Agaña, Island of Guam, for 1902,' presents a discussion, along approved lines, of the data collected during one year at Guam, and while the period is very short, the tropical conditions of the island make a long series of observations much less necessary than is the case in a higher latitude. Professor A. J. Henry, of the Weather Bureau, in an account of 'A Climatological Dictionary of the United States,' calls attention to the summary of the climatological work that has been done in this country which is now in preparation by the Weather Bureau. The first chapter of the new volume, which is really a census of the climatology of the United States, will treat of the broader features of climate, and the remaining chapters will deal with the climates of the several states and territories. The records of about 600 stations will be used. The 'Scientific Work of Mount Weather Meteorological Research Observatory' is considered by Professor F. H. Bigelow, who states that the Weather Bureau is 'looking to the future needs of a rapidly developing and intensely interesting branch of science' and is 'trying to build the very best observatory possible.' Frequent mention of the Mount Weather Observatory has been made in these

notes. The disregard of the cyclonic element in climatological summaries is believed by R. DeC. Ward to be a distinct disadvantage, in his 'Suggestions concerning a more Rational Treatment of Climatology.' Annual, monthly and daily summaries, being concerned with final and definite periods, do not bring out the variations of the climatic elements under cyclonic control, and yet the irregular cyclonic changes are the very ones which most closely affect man. In a rather striking way, a paper by Dr. H. R. Mill, 'On the Unsymmetrical Distribution of Rainfall about the Path of a Barometric Depression crossing the British Isles,' emphasizes the value of a discussion of one element of climate—in this case rainfall—on the basis of the cyclonic, not the diurnal or weekly, unit. Dr. Mill's study of the distribution of rainfalls in relation to the individual cyclones which produce these rains is a distinct advance on the usual summaries of the conventional kind. Papers on climate are contributed as follows: Canada, by R. F. Stupart, director of the Canadian Meteorological Service; Kimberley, by J. R. Sutton, meteorologist of the De Beers Mines; Natal, by F. W. D'Evelyn; Pamplemousses, Mauritius, by T. F. Claxton, director of the Royal Alfred Observatory, Mauritius; Ts' Aidam, Tibet, by A. Kaminski; Western Australia, by W. Ernest Cooke, government astronomer of Western Australia. Two papers on meteorological exploration are contributed, one (abstract) by A. Lawrence Rotch, 'A Project for the Exploration of the Atmosphere over the Tropical Oceans,' a plan which Mr. Rotch was able to carry into effect during the past summer; and one by H. Arctowski, on 'Antarctic Meteorology and International Co-operation in Polar Work.' Mr. Wm. Marriott, assistant secretary of the Royal Meteorological Society, contributes a paper on 'Rainfall with Altitude in England and Wales,' in which the data for 1881–1890 are dealt with. The increase of rainfall with altitude; the greater rainfall in the west than in the east, and the greater range of the monthly rainfall in the west are the more important points brought out.

REPORT OF THE CHIEF OF THE WEATHER BUREAU.

The annual report of the chief of the Weather Bureau (for the year ending June 30, 1904) has recently been published. The forecasts of hurricanes, gales, snow, cold waves, etc., were successful, and their economic value was generally recognized. The River and Flood Service is to be extended. Long-range forecasts, issued by various persons for a month or so in advance, continue to give Weather Bureau officials much trouble, and the matter is given some attention in the present volume. The conclusions reached by the bureau (p. xvii) are the logical ones, but we are inclined to believe that it is a mistake for our Weather Bureau to pay too much attention to these 'fake' forecasts. Advertising is what some persons most desire, and we should suppose that the 'weather prophet' might increase the number of subscribers to his publications as a result of the notoriety gained in this way. It is encouraging to note the cooperation of several universities and colleges with the Weather Bureau. Some of these institutions have given the government land for the erection of meteorological stations, and others (Brown and the University of Wisconsin) have provided, without cost, office quarters for recently established stations. A considerable series of investigations to be carried on at Mount Weather is enumerated.

HEALTH, DISEASE, DEATHS AND THE WEATHER.

From the earliest times, the relations between weather conditions and health have attracted attention. In recent years, with the discovery of the micro-organisms which cause many diseases, our notions regarding the effects of weather and climate have undergone considerable change. Nevertheless, there are many direct and indirect relations between meteorological conditions and the prevalence of, and deaths from, certain diseases which can not fail to impress any one who studies vital statistics. For the United States some interesting material along these lines may be found in the 'Vital Statistics' section of the Statistical Atlas of the Twelfth Census, recently issued. Charts and diagrams show the

death rates from various diseases in selected areas, in cities and in rural districts. The proportion of deaths at all ages (1900) was highest in March; the deaths of children under five were at a maximum in August. For diseases of the respiratory system, the deaths are at a maximum in the colder months, as is usually the case, for obvious reasons. The same is true for diseases of the circulatory system and for diphtheria. On the other hand, for diarrheal diseases, typhoid fever and malarial fever, the maxima come in the warmer months.

R. DeC. Ward.

Harvard University.

THE AMERICAN PHYSIOLOGICAL SOCIETY.

At the meeting of this society held in Ann Arbor, Michigan, December 28 and 29, the following officers were elected:

President—Professor William H. Howell, Baltimore, Md.

Secretary—Professor Lafayette B. Mendel, New Haven, Conn.

Treasurer—Professor Walter B. Cannon, Boston, Mass.

Additional Members of the Council—Professor A. B. Macallum, Toronto, Canada; Dr. S. J. Meltzer, New York City.

The following new members of the society were elected: Dr. C. L. Alsberg, instructor in biological chemistry, Harvard Medical School, Boston, Mass.; Dr. E. G. Martin, associate professor of physiology, Purdue University, Lafayette, Indiana; Dr. John Auer, fellow of the Rockefeller Institute, New York City; Dr. C. W. Edmunds, lecturer on materia medica and therapeutics, University of Michigan, Ann Arbor, Michigan; Dr. W. B. Pillsbury, director of the psychological laboratory, University of Michigan, Ann Arbor; Dr. S. A. Matthews, associate in pharmacology, University of Chicago; Dr. Swale Vincent, professor of physiology, University of Manitoba, Winnipeg, Canada; Dr. Shinkishi Hatai, assistant in neurology, University of Chicago; Dr. V. E. Henderson, demonstrator of physiology and pharmacology, University of Toronto; Dr. William Salant, assistant in physiological chemistry, Columbia University and fellow of the Rockefeller Institute, New York City; Dr. O. P. Terry, assistant in physiology, St. Louis University; Dr. C. C. Guthrie, instructor in physiology, University of Chicago; Dr. R. S. Lillie, instructor in physiology, Harvard Medical School, Boston; Dr. J. H. Kastle, chief of Division of Chemistry, U. S. Public Health and Marine Hospital Service.

The scientific proceedings of the society's meetings will be published in the February number of *The American Journal of Physiology*. It is probable that the next annual meeting of the society will be held in New York City during convocation week, 1906–7.

THE CONGRESS OF THE UNITED STATES.

The following bills have been introduced in the house of representatives:

December 13, 1905.

Introduced by Mr. Needham, a bill (H. R. 7017) providing for the transfer of certain national parks from the Department of the Interior to the Department of Agriculture. Referred to the committee on public lands.

By Mr. Lacey, a bill (H. R. 7019) for the protection of animals, birds and fish in the Forest Reserves. Referred to the committee on agriculture.

By Mr. Stevens, of Minnesota, a bill (H. R. 7108) to authorize the establishment of fish culture and biology stations in the United States. Referred to the committee on merchant marine and fisheries.

December 18, 1905.

A bill introduced by Senator Teller (S. 2193) for a public building for the United States Geological Survey at Washington, D. C. Referred to the committee on public buildings and grounds.

By unanimous consent upon motion of Senator Cullom, a bill passed in the senate on December 19, to appropriate the sum of $25,000 to establish a Fish Cultural Station in the State of Illinois.

SCIENTIFIC NOTES AND NEWS.

The American Association for the Advancement of Science having decided to hold its next regular meeting in New York City in convocation week, beginning December 27,

1906, there will be a meeting of the fellows and members of the association residing in New York City, or within a radius of fifty miles, on Thursday, January 18, at 4:30 P.M., in room 305, Schermerhorn Hall, Columbia University. Members of societies likely to meet next year in affiliation with the association are invited to be present whether or not they are members of the association.

AT the New Orleans meeting of the Botanical Society of America, Dr. F. S. Earle, director of the Agricultural Station in Cuba, was elected president; Dr. William Trelease, director of the Missouri Botanical Garden, secretary, and Dr. Arthur Hollick, of the New York Botanical Garden, treasurer. It is expected that the same officers will be elected by the Society for Plant Morphology and Physiology and by the American Mycological Society, which have effected a union with the Botanical Society of America.

AT the New York meeting of the Astronomical and Astrophysical Society of America, on December 28–30, 1905, the following officers were elected for the ensuing year:

President—E. C. Pickering.
First Vice-President—G. E. Hale.
Second Vice-President—W. W. Campbell.
Secretary—G. C. Comstock.
Treasurer—C. L. Doolittle.
Councilors—E. B. Frost and Harold Jacoby.

Councilors Ormond Stone and W. S. Eichelberger hold over from the preceding year. The time and place of the next meeting will be determined by the council.

DURING the Christmas holidays, in connection with the annual meeting at Baltimore of the Economic Association and the Political Science Association, a new national association, to be known as the American Sociological Society, was formed by about fifty sociologists who were gathered there for this purpose. The new organization will meet at the same time and place as the American Economic Association, and in the constitution adopted at Baltimore its objects are stated to be 'the encouragement of sociological research and discussion, and the promotion of intercourse between persons interested in the scientific study of society.' While the new society will include in its members those 'practical sociologists,' that is to say, social reform workers, as well as theoretical and academic sociologists, the predominating viewpoint in its discussions is to be scientific, rather than popular or propagandist. The call for the conference which resulted in the formation of the society was signed by T. N. Carver, of Harvard; F. H. Giddings, of Columbia; S. M. Lindsay and S. N. Patten, of Pennsylvania; E. A. Ross, of Nebraska; A. W. Small, of Chicago; W. G. Sumner, of Yale; C. W. A. Veditz, of George Washington University; and Lester F. Ward, of the Smithsonian Institution. The officers of the new society for the current year are:

President—Lester F. Ward.

Vice-Presidents—W. G. Sumner, of Yale, and F. H. Giddings, of Columbia.

Secretary and Treasurer—C. W. A. Veditz, of George Washington.

Executive Committee (in addition to the above) —A. E. Ross, W. F. Willcox, A. W. Small, S. M. Lindsay, D. C. Wells and William Davenport.

AT the annual meeting of the Philadelphia Academy of Natural Sciences, on December 19, Dr. Samuel G. Dixon was reelected president; Dr. Edward J. Nolan, recording secretary and librarian; Dr. Charles B. Penrose, councilor for three years. and Dr. Horatio C. Wood, councilor to fill an unexpired term.

AT the recent meeting of the California Teachers' Association held at the University of California, the section of mathematics adopted *School Science and Mathematics* as its official journal and elected the following officers for the ensuing year:

President—Professor G. A. Miller, Stanford University.

Vice-President—Professor W. H. Baker, San Jose Normal School.

Secretary—Principal J. Fred Smith, Campbell High School.

AT the meeting of the Entomological Society of France of December 13, three honorary members were elected to fill the vacancies in the list of twelve honorary members caused by the deaths of Packard, Saussure and Friedrich Brauer. Dr. M. Standfuss, professor in the Polytechnicum in Zurich,

especially known by his investigations in Lepidoptera, in the production of varieties by the influence of heat, cold and moisture, was elected to fill the vacancy caused by Saussure's death. Professor Antonio Berlese, director of the Entomological Station of Florence, and especially known for his important studies on Coccidæ, his classical researches upon the internal phenomena of the metamorphoses of insects and his large memoir on the Acari, Myriapoda and scorpions of Italy, was elected to fill the vacancy caused by Brauer's death. Dr. L. O. Howard, chief of the Bureau of Entomology of the U. S. Department of Agriculture at Washington, fills the place caused by the death of Packard; the reasons given for his election being his work in entomology as applied to agriculture and medicine and his systematic work upon the Chalcididæ and other parasitic Hymenoptera, especially in their relation to the enemies of agriculture.

Dr. S. T. Tamura, B.Sc., M.A. (Iowa), Ph.D. (Columbia), a native of Japan, has been appointed mathematician in the department of terrestrial magnetism of the Carnegie Institution, with which he has been connected as assistant for the past two years.

A telegram to the London papers states that Sir David Gill has made a public announcement that he intends to retire from the position of director of the Cape of Good Hope Observatory.

It is said that Dr. Koch has been placed at the head of an expedition to eastern Africa to investigate the sleeping sickness, for which the German government has appropriated $30,000.

We learn that the eminent paleontologist, Professor W. Amalitzky, of Warsaw, whose death at the hands of revolutionaries was recently reported, is still alive and safe in his own house. A grim light, however, is cast on the situation in Poland by the fact that it took more than a month for the Russian embassy in London to obtain this information.

Dr. R. Burton-Opitz, adjunct professor of physiology at Columbia University, who has for some years been the American editor of the *Biochemische Centralblatt,* has also become American editor of the *Bio-physikalische Centralblatt* and of the *Hygienische Centralblatt,* published by Bornträger Brothers, of Berlin. American scientific men are requested to send to Dr. Opitz, at the College of Physicians and Surgeons, 437 West 49th St., New York, abstracts of their papers and reprints of publications bearing on the subjects included in the scope of these journals.

Dr. Maynard M. Metcalf, who recently accepted the chair of zoology at Oberlin College, will spend the year 1906–7 in Germany, and will enter on his work at Oberlin in September, 1907. In the meanwhile his address will continue to be The Woman's College, Baltimore, Md.

Dr. Otto Nordenskjöld gave an illustrated lecture before the Geographical Society of Philadelphia on January 4. He took as his subject, 'Two Years amongst the Ice of the South Pole.'

Professor Roland Thaxter, of Harvard University, has a year's leave of absence, during which he will make botanical collections in South America.

Dr. Sven Hedin, the Swedish explorer, has arrived at Teheran.

A memorial medal in honor of Andrée has been made by Londberg, the Swedish engraver. The artist represents Andrée's balloon rising from the ice. The explorer is looking anxiously toward the north. A group of young men are applauding, while an old man looks toward the horizon doubtfully. Below is the date, July 11, 1897. On the obverse appears the profile of Andrée.

Dr. Otto A. Moses, the geologist and chemist and at one time state geologist of South Carolina, died on January 3 at the age of sixty years. Dr. Moses founded the Hebrew Technical Institute of New York City.

Charles Jasper Joly, F.R.S., astronomer royal of Ireland, and professor of astronomy, at Dublin University, also known for his contributions to quaternions, has died at the age of forty-two years.

The death is announced of Mr. Frederick William Burbidge, M.A., curator of the

Botanical Gardens of Trinity College, Dublin, at the age of fifty-nine years.

Dr. Philipp-Balliff, the German meteorologist, died on November 6, at the age of sixty years.

The daily papers state that Mr. Radiguet, the French instrument-maker and man of science, has died as the result of exposure to the Röntgen rays.

The will of the late Charles T. Yerkes, who owed his large fortune to the direct application of recent advances in science, makes provision for three important institutions, which are to bear his name. The Yerkes Observatory, to which he has already contributed liberally, receives $100,000, the Yerkes galleries and the Yerkes hospital are to be established in New York City, on the death of his widow, or sooner should she wish. The hospital will also be established in case of the death of one of the two children. After certain bequests to Mrs. Yerkes, to his son and daughter and to others have been made, a trust fund is established, most of which will ultimately go to the support of the hospital. It is said that the value of the house on Fifth Avenue to be used for the galleries is $1,000,000, and that the value of the collections is $4,000,000. $750,000 are provided as an endowment fund for the galleries, which will be under the control of the Metropolitan Museum of Art. The hospital, which is to be situated in the borough of the Bronx, will receive, it is estimated by the daily papers, from $5,000,000 to $16,000,000.

The letter of President Roosevelt to Chief Justice Fuller, chancellor of the Smithsonian Institution, recommending the acceptance of the art collections of Mr. Charles A. Freer, has been widely published, and has probably led to some misunderstanding. The regents of the Smithsonian Institution fully appreciate the value of Mr. Freer's collections and the desirability of having them at Washington, and his liberality in not only giving the collections, but in also consenting to provide on his death a building to house them. But he makes the condition that nothing shall be added to or taken from the collection after his death, and it would be necessary for the Smithsonian Institution to provide some $10,000 for its maintenance. This can only be done by a congressional appropriation, and can not be definitely promised.

Dr. Isaiah F. Everhart, of Scranton, Pa., has offered to present his natural history collection to the city, and to erect a $50,000, building for its accommodation at Nayaug Park.

The public library of New London, Conn., will ultimately receive $40,000 by the will of Mr. Henry Cecil Haven.

As an outcome of the formation of the division for the investigation of artesian waters by the United States Geological Survey three years ago a considerable number of geologists are now devoting their entire time to the investigation of underground waters and related geology. The need of a society for the discussion of the many problems constantly arising in connection with new lines of research or investigations of more extended scope than those previously undertaken, has been felt for some time. Preliminary meetings looking to the organization of such a society were held on December 9 and 11, and on December 20 a formal meeting was held at which the society was formally organized, a constitution adopted, and officers chosen. The association, which is known as the 'Society of Geohydrologists,' is composed of active members, consisting of residents of the District of Columbia or vicinity who are principally engaged in geohydrologic work, and associate members consisting of non-residents who have contributed prominently to the science of geohydrology, making it a strictly professional society. Meetings will be held on the first and third Wednesdays of each month during the winter.

Professor Russell H. Chittenden, director of the Sheffield Scientific School, Yale University, has announced the following lectures, composing the fortieth annual Sheffield lecture course:

January 19.—'The Panama Canal.' Professor William H. Burr.

January 26.—'Alaska.' Mr. Howard W. DuBois, M.E.

February 2.—'The Evolution of the Sense of Hearing.' Professor George H. Parker.

February 9.—'Africa, from Sea to Center.' Mr. Herbert L. Bridgman.

February 16.—'Total Solar Eclipses and their Significance.' Professor Charles S. Hastings.

February 23.—'Florida Bird-Life, with special reference to the Life History of the Brown Pelican.' Mr. Frank M. Chapman.

March 2.—'The Wheat Country of the Northwest.' Dr. Claude F. Walker.

March 9.—'How the Metal Calcium was isolated; a Story of Chemical Progress.' Professor Edgar F. Smith.

March 16.—'The Colorado Canyon and its Lessons.' Professor William M. Davis.

March 23.—'Botanizing among the American Indians.' Mr. Frederick V. Coville.

UNIVERSITY AND EDUCATIONAL NEWS.

The Pennsylvania College for Women in Pittsburg, has been making a resolute struggle to pay off a mortgage indebtedness of over $60,000 resting upon its property, and to make a beginning in securing an endowment. $40,000 were pledged to the latter purpose in case $150,000 should be subscribed by January 1, 1906. The necessary subscriptions have been secured, and, after the mortgage has been paid, the college will possess as the nucleus of an endowment fund the sum of $125,000. It has a fine landed property and good buildings.

Mr. Andrew Carnegie has promised to contribute $50,000 toward the endowment fund of Bates College when $100,000 shall have been raised for the same purpose by friends of the college.

The University of Pennsylvania received last month an anonymous gift of $50,000.

Lake Forest University has received $30,000 for a dormitory and the same sum for a commons.

The University of Wisconsin has received a bequest of $10,000 by the will of the late Mrs. Fannie Parker Lewis, for the establishment of scholarships for young women students in need of financial aid.

Mr. John Feeney bequeathed sums amounting to £89,000 towards various institutions and objects connected with Birmingham and district. These include Birmingham Art Gallery, £50,000; University of Birmingham, £20,000, and the General Hospital, £10,000. The bequest to the university is for the purpose of maintaining a professor, with suitable equipment, lecturing on some one or more scientific subjects directly connected with some one or more of the trades and industries carried on in or near Birmingham.

Sir Donald Currie's offer of £20,000 to Queen's College, Belfast, on condition that a similar sum was raised locally, has met with a satisfactory response. The president of the college has announced that the conditions have been more than complied with, and that with the amount secured previously the sum now stands at over £70,000.

The senate of London University invites applications for the professorship of protozoology, established by means of funds offered by the Royal Society and the Rhodes trustees, through the colonial secretary. The salary attached to the chair will be £750 per annum.

At the annual meeting of the trustees of the Massachusetts Agricultural College, on January 2, at the rooms of the State Board of Agriculture, Kenyon L. Butterfield, president of the Rhode Island College of Agriculture and Mechanic Arts, was elected to fill the vacancy in the presidency at Amherst caused by the death of Henry H. Goodell. He will assume his duties in July.

The regents of the University of Wisconsin have arranged for State Forester E. M. Griffith to deliver a course of lectures on forestry before the students of the university.

Dr. Walter Mulford, last year instructor in Yale University, has been made assistant professor of forestry in the University of Michigan.

M. Barbillion has been appointed professor of technical physics in the University of Grenoble.

Dr. Karl Chun, professor of zoology in the University of Leipzig, has declined a call to Berlin.